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SIMULATION OF TRIPLE-SPOOL TURBOFAN ENGINE

Edward K. Norvaisis

Air Force Aero Propulsion Laboratory
Wright-Patterson Air Force Base, Ohio

April 1974

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Ernest C Simpson
ERNEST C. SIMPSON
Chief, Turbine Engine Division
Air Force Aero Propulsion Laboratory

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This report describes a digital computer program entitled TRISPL. TRISPL is a computer program that simulates steady-state design and off-design performance of triple-spool turbofan engines. The program has been formulated for an engine type with two core spools and one fan spool but can easily be modified for other engine types (two fan spools and one core spool, for example). The program, written in Fortran IV language, uses performance maps (in Block Data format)

Block Nr 20

of the major engine components. Information on setting up the Block Data and input data is given in the report. Also included is a complete program listing with a description of each subroutine and sample results.

FOREWORD

This report was prepared in the Performance Branch (AFAPL/TBA), Turbine Engine Division, Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio, under Project 668A0215, with Edward K. Nervaisis as Project Engineer.

This report covers work conducted within the Performance Branch in the time period between April 1973 and January 1974.

ABSTRACT

This report describes a digital computer program entitled TRISPL. TRISPL is a computer program that simulates steady-state design and off-design performance of triple-spool turbofan engines. The program has been formulated for an engine type with two core spools and one fan spool but can easily be modified for other engine types (two fan spools and one core spool, for example). The program, written in Fortran IV language, uses performance maps (in Block Data format) of the major engine components. Information on setting up the Block Data and input data is given in the report. Also included is a complete program listing with a description of each subroutine and sample results.

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SYMBOLS

STATION NUMBERS

1	ambient
2	fan entrance
21	fan exit/intermediate compressor and duct entrance
22	intermediate compressor exit/high compressor entrance
3	high compressor exit/burner entrance
4	burner exit/hi pressure turbine entrance
45	hi press. turbine exit/int. press. turbine entrance
5	int. turbine exit/low press. turbine entrance
55	low press. turbine exit
6	afterburner entrance
7	afterburner exit
8	main nozzle throat
9	main nozzle exit
23	duct burner entrance
24	duct burner exit
25	duct exit if mixed flow engine
28	duct nozzle throat
29	duct nozzle exit

THERMODYNAMIC PROPERTIES

T	total temperature (degrees R)
P	total pressure (atm)
H	total enthalpy (Btu/lbm)
S	total entopy (Btu/lbm °R)

TS	static temperature (degrees R)
PS	static pressure (atm)
FAR	fuel-air ratio
AM	Mach number
V	velocity (ft/sec)

COMPONENT SYMBOLS

F	fan
I	intermediate (middle) compressor
C	high pressure compressor
B, COM	combustor
D, DUC	fan duct
THP	high pressure turbine
TIP	intermediate turbine
TLP	low pressure turbine
A, AFT	afterburner
NOZ	nozzle
M	main nozzle
OB	overboard
T	total

ENGINE SYMBOLS

ETAR	ram recovery, P2/P1
CN	ratio of corrected speed to design corrected speed
PCN	percent of design shaft speed
PR	pressure ratio

In addition to all input symbols, the following are output:

A	areas (ft^2)
AM	Mach numbers
BLDU	total bleed flow into duct (lbm/sec)
BLDUC	bleed flow into duct from high-pressure compressor (lbm/sec)
BLDUI	bleed flow into duct from intermediate compressor (lbm/sec)
BLC	high-pressure compressor bleed flow (lbm/sec)
BLF	fan bleed flow, overboard (lbm/sec)
BLHP	total bleed flow to high-pressure turbine (lbm/sec)
BLHPC	high-pressure turbine cooling bleed from high-pressure compressor (lbm/sec)
BLHPI	high-pressure turbine cooling bleed from intermediate compressor (lbm/sec)
BLI	intermediate compressor bleed blow (lbm/sec)
BLIP	total bleed flow to intermediate turbine (lbm/sec)
BLIPC	intermediate turbine cooling bleed from high-pressure compressor (lbm/sec)
BLIPI	intermediate turbine cooling bleed from intermediate compressor (lbm/sec)
BLLP	total bleed flow to low-pressure turbine (lbm/sec)
BLLPC	low-pressure turbine cooling bleed from high-pressure compressor (lbm/sec)
BLLPI	low-pressure turbine cooling bleed from intermediate compressor (lbm/sec)
BLOB	total overboard bleed flow (lbm/sec)
BLOBC	overboard bleed flow from high-pressure compressor (lbm/sec)
BLOBI	overboard bleed flow from intermediate compressor (lbm/sec)

FGP	pressure thrust (lbf)
FN	net thrust (lbf)
FRD	ram drag (lbf)
GU	initial or guessed values
ITRYS	number of loops thru engine before quitting
LOOPER	number of loops thru engine
SFC	specific fuel consumption (lbm/lbf/hr)
TOLALL	tolerance on convergence
VA	flight speed (ft/sec)
VJ	jet velocity (ft/sec)

INPUT SYMBOLS

ALTP	altitude (ft)
AM	flight Mach number
AM55	Mach number at low pressure turbine exit
AM6	afterburner entrance Mach number at design
A8	main nozzle throat area - can be changed at off design - (ft^2)
A28	duct nozzle throat area - can be changed at off design - (ft^2)
CNHPDS	design corrected speed - high pressure turbine
CNIPDS	design corrected speed - intermediate turbine
CNLPDS	design corrected speed - low pressure turbine
CVDNOZ	duct nozzle velocity coefficient
CVMNOZ	main nozzle velocity coefficient
DELFG, DELFN, DELSFC	delta degradation multiplier for gross thrust, net thrust, and specific fuel consumption, respectively. Usually input as 1.0
DPAFDS	afterburner design pressure drop, $\Delta P/P$
DPCODS	combustor design pressure drop, $\Delta P/P$

DTCODS	combustor design temperature rise, ΔT (°R)
ETAA	afterburner efficiency
ETABDS	combustor efficiency at design
ETACDS	high-pressure compressor adiabatic efficiency at design
ETAD	duct burner efficiency
ETAFDS	fan adiabatic efficiency at design
ETAIDS	intermediate compressor adiabatic efficiency at design
ETAR	ram recovery, P2/P1
ETHPDS	high-pressure turbine adiabatic efficiency at design
ETIPDS	intermediate turbine adiabatic efficiency at design
ETLPDS	low-pressure turbine adiabatic efficiency at design
HPEXT	horsepower extraction
IAFTBN	index on afterburning desired
IAMTP	index on ram or inlet operation desired
IDBURN	index on duct burning desired
IDCD	duct nozzle will be convergent-divergent when IDCD=1
IDES	index for design point: must be set equal to 1 to design engine; zeroed automatically
IDUMP	index for dumping error matrix
IGASMX	index for mixed flow or non-mixed flow turbofans
IMCD	main nozzle will be convergent-divergent when IMCD=1
ITRYS	index for maximum number of iterations
MODE	independent variable designator for engine operation
NOZFLT	index for floating main or duct nozzle
PCBLC	% of total high-pressure compressor airflow that is bled
PCBLDUC	% of high-pressure compressor bleed flow that is bled into duct

PCBLDUI	% of intermediate compressor bleed flow that is bled into duct
PCBLF	% of total fan airflow that is bled (overboard)
PCBLHPC	% of high-pressure compressor bleed flow that is bled to the high-pressure turbine
PCBLHPI	% of intermediate compressor bleed flow that is bled to the high pressure turbine
PCBLI	% of total intermediate compressor airflow that is bled
PCBLIPC	% of high-pressure compressor bleed flow that is bled to the intermediate turbine
PCBLIPI	% of intermediate compressor bleed flow that is bled to the intermediate turbine
PCBLLPC	% of high-pressure compressor bleed flow that is bled to the low-pressure turbine
PCBLLPI	% of intermediate compressor bleed flow that is bled to the low-pressure turbine
PCBLOBC	% of high pressure compressor bleed flow that is bled overboard
PCBLOBI	% of intermediate compressor bleed flow that is bled overboard
PCNC	high-pressure compressor shaft speed as a percent
PCNCDS	design high-pressure compressor shaft speed as a percent
PCNF	fan shaft speed as a percent
PCNFDS	design fan shaft speed as a percent
PCNI	intermediate compressor shaft speed as a percent
PCNIDS	design intermediate compressor shaft speed as a percent
PRCDS	high-pressure compressor pressure ratio at design
PRFDS	fan pressure ratio at design
PRIDS	intermediate compressor pressure ratio at design
PS55	static pressure at low-pressure turbine exit (atm)
P2	fan face total pressure, for nonstandard days (atm)

TFHPDS	high-pressure turbine flow function at design
TFIPDS	intermediate turbine flow function at design
TFLPDS	low-pressure turbine flow function at design
TOLALL	tolerance on convergence at error matrix
T2	fan face total temperature, for nonstandard days (°R)
T24	duct-burner exit temperature, when ductburning (°R)
T4	conbustor exit/turbine inlet temperature (°R)
T4DS	combustor exit/turbine inlet temperature at design (°R)
T7	afterburner exit temperature, when afterburning (°R)
WFA	afterburner fuel flow rate, IAFTBN=2 (lbm/sec)
WFB	main combustor fuel flow rate, MODE=2 (lbm/sec)
WFBDS	combustor fuel flow rate at design, MODE=2 (lbm/sec)
WFD	duct burner fuel flow rate, IDBURN=2 (lbm/sec)
ZCDS, ZFDS, ZIDS	design ratio of high pressure compressor, fan, and intermediate compressor respectively; equals pressure ratio at design on design speed line minus one divided by high(surge) value minus one on the design speed line

OUTPUT SYMBOLS[1]

[1] Some symbols, such at T, are followed by station numbers; see station number symbols

In addition to all input symbols, the following are output:

A	areas (ft^2)
AM	Mach numbers
BLDU	total bleed flow into duct (lbm/sec)
BLDUC	bleed flow into duct from high-pressure compressor (lbm/sec)
BLDUI	bleed flow into duct from intermediate compressor (lbm/sec)
BLC	high-pressure compressor bleed flow (lbm/sec)
BLF	fan bleed flow, overboard (lbm/sec)
BLHP	total bleed flow to high-pressure turbine (lbm/sec)
BLHPC	high-pressure turbine cooling bleed from high-pressure compressor (lbm/sec)
BLHPI	high-pressure turbine cooling bleed from intermediate compressor (lbm/sec)
BLI	intermediate compressor bleed blow (lbm/sec)
BLIP	total bleed flow to intermediate turbine (lbm/sec)
BLIPC	intermediate turbine cooling bleed from high-pressure compressor (lbm/sec)
BLIPI	intermediate turbine cooling bleed from intermediate compressor (lbm/sec)
BLLP	total bleed flow to low-pressure turbine (lbm/sec)
BLLPC	low-pressure turbine cooling bleed from high-pressure compressor (lbm/sec)
BLLPI	low-pressure turbine cooling bleed from intermediate compressor (lbm/sec)
BLOB	total overboard bleed flow (lbm/sec)
BLOBC	overboard bleed flow from high-pressure compressor (lbm/sec)
BLOBI	overboard bleed flow from intermediate compressor (lbm/sec)

BYPASS	bypass ratio, duct airflow divided by intermediate compressor airflow
CNC	high pressure compressor corrected shaft speed as a percent
CNF	fan corrected shaft speed as a percent
CNHP	high pressure turbine corrected shaft speed as a percent, PCNC/$\sqrt{T4}$
CNHPCF	high pressure turbine speed correction factor
CNI	intermediate compressor corrected speed as a percent
CNIP	intermediate turbine corrected shaft speed as a percent, PCNI/$\sqrt{T45}$
CNIPCF	intermediate turbine speed correction factor
CNLP	low-pressure turbine corrected shaft speed as a percent, PCNF/$\sqrt{T5}$
CNLPCF	low-pressure turbine speed correction factor
CS	ambient speed at sound (ft/sec)
DHHPCF	high-pressure turbine work correction factor
DHIPCF	intermediate turbine work correction factor
DHLPCF	low-pressure turbine work correction factor
DHTC	high-pressure turbine work, ΔH, (Btu/lbm)
DHTCHP	high-pressure turbine work, temperature corrected, $\Delta H/T$ (Btu/lbm °R)
DHTCIP	intermediate turbine work, temperature corrected, $\Delta H/T$ (Btu/lbm °R)
DHTCLP	low-pressure turbine work, temperature corrected, $\Delta H/T$ (Btu/lbm °R)
DHTF	low-pressure turbine work, ΔH (Btu/lbm)
DHTI	intermediate turbine work, ΔH (Btu/lbm)
DPAFT	afterburner/tailpipe pressure, loss, $\Delta P/P$
DPCOM	combustor pressure loss, $\Delta P/P$
DPDUC	fan duct pressure loss, $\Delta P/P$

DTAFCF	afterburner temperature rise correction factor
DTAFDS	afterburner temperature rise at design, ΔT (°R)
DTCOCF	Combustor temperature rise correction factor
DTDUCF	duct-burner temperature rise correction factor
DTDUDS	duct-burner temperature rise at design, ΔT (°R)
ETAACF	afterburner efficiency correction factor
ETAADS	afterburner efficiency at design
ETAB	combustor efficiency
ETABCF	combustor efficiency correction factor
ETAC	high-pressure compressor adiabatic efficiency
ETACCF	high-pressure compressor efficiency correction factor
ETAD	ductburner efficiency
ETADCF	duct burner efficiency correction factor
ETADDS	ductburner efficiency at design
ETAF	fan adiabatic efficiency
ETAFCF	fan efficiency correction factor
ETAI	intermediate compressor adiabatic efficiency
ETAICF	intermediate compressor efficiency correction factor
ETATHP	high-pressure turbine adiabatic efficiency
ETATIP	intermediate turbine adiabatic efficiency
ETATLP	low-pressure turbine adiabatic efficiency
ETHPCF	high-pressure turbine efficiency correction factor
ETIPCF	intermediate turbine efficiency correction factor
ETLPCF	low-pressure turbine efficiency correction factor
FAR	fuel-air ratios
FART	total fuel-air ratio
FG	gross thrust (lbf)

FGM	momentum thrust, total (lbf)
FGMD	momentum thrust from duct (lbf)
FGMM	momentum thrust from core (lbf)
FGP	total pressure thrust (lbf)
FGPD	pressure thrust from duct (lbf)
FGPM	pressure thrust from core (lbf)
FN	net thrust (lbf)
FRD	ram drag (lbf)
H	enthalpies (Btu/lbm)
P	total pressures (atm)
PCNC	high-pressure compressor shaft speed as a percent
PCNCGU	first guess of PCNC
PCNF	fan shaft speed as a percent
PCNFGU	first guess at PCNF
PCNI	intermediate compressor shaft speed as a percent
PCNIGU	first guess at PCNI
PRC	high pressure compressor pressure ratio
PRCCF	high pressure compressor pressure ratio correction factor
PRF	fan pressure ratio
PRFCF	fan pressure ratio correction factor
PRI	intermediate compresser pressure ratio
PRICF	intermediate compressor pressure ratio correction factor
PS	static pressures (atm)
S	entropies (Btu/lbm -°R)
SFC	specific fuel consumption (lbm/lbf/hr)
T	total temperatures (°R)

TS	static temperatures
T2DS	fan face total temperature at design (°R)
T21DS	fan exit total temperature at design (°R)
T22DS	intermediate compressor exit total temperature at design (°R)
T24DS	ductburner exit temperature at design (°R)
T7DS	afterburner exit temperature at design (°R)
T4GU	first guess at T4 (°R)
TFFHP	high-pressure turbine flow function
TFFIP	intermediate turbine flow function
TFFLP	low-pressure turbine flow function
TFHPCF	high-pressure turbine flow function correction factor
TFIPCF	intermediate turbine flow function correction factor
TFLPCF	low-pressure turbine flow function correction factor
V	velocities (ft/sec)
VA	aircraft velocity (ft/sec)
VJD	fan duct exhaust velocity (ft/sec)
VJM	core exhaust velocity (ft/sec)
WA	airflows (lbm/sec)
WAC	high-pressure compressor airflow (lbm/sec)
WACC	high-pressure compressor corrected airflow (lbm/sec)
WACCF	high-pressure compressor airflow correction factor
WACDS	high-pressure compressor airflow at design (lbm/sec)
WAD	duct airflow (lbm/sec)
WAF	fan airflow (lbm/sec)
WAFC	fan corrected airflow (lbm/sec)
WAFCF	fan airflow correction factor

WAI	intermediate compressor airflow (lbm/sec)
WAIC	intermediate compressor corrected airflow (lbm/sec)
WAICF	intermediate compressor airflow correction factor
WA3CDS	high-pressure compressor exit corrected airflow at design (lbm/sec)
WA23CDS	ductburner entrance corrected airflow at design (lbm/sec)
WFADS	afterburner fuel flow rate at design (lbm/sec)
WFDDS	ductburner fuel flow rate at design (lbm/sec)
WFT	total fuel flow rate (lbm/sec)
WGT	total gas flow rate (lbm/sec)
WG6CDS	afterburner entrance corrected gas flow at design (lbm/sec)
ZC, ZF, ZI	similar to ZCDS, ZFDS, and ZIDS except these are off-design - see Input Symbols

SECTION I

INTRODUCTION

In 1967, a digital computer program for balancing cycle turbofan engines titled SMOTE was developed in the Air Force Aero Propulsion Laboratory (Reference 1). This program is capable of simulating design and off-design performance of two-spool turbofan engines. This report describes a similar technique, obtained by modifying the SMOTE program, that simulates design and off-design performance of three-spool turbofan engines. NASA, Pratt and Whitney, General Electric and other contractors have developed or are developing working models that simulate the performance of three spool engines. However, through the experience gained in developing an in-house computer program, more flexibility can be exercised in making modifications to satisfy varying future needs without being dependent on contractors or other organizations.

Three-spool turbofan engines will be competitive as candidates for powering future aircraft systems. This effort has provided the Air Force Aero Propulsion Laboratory with an in-house method for evaluating the peformance of three-spool turbofan engines.

SECTION II

SUMMARY

A computer program titled TRISPL is described. This program is derived from SMOTE (Simulation of Turbofan Engine) which was developed by the Turbine Engine Division of the AF Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio.

TRISPL calculates design and off-design performance of 3-spool turbofan engines. Component maps, input as block data, are scaled internally to simulate a specific engine. The program is formulated for two core spools and one fan spool operation. Options are included for mixed or separate flow engines and dry or afterburning operation. The program can be modified for different modes of operation and engine types, 2 fan spools and one core spool for example.

SECTION III

METHOD OF ENGINE CALCULATIONS

The following discussion is very similar to that in the report describing the SMOTE program.

1. COMPONENT MAPS

The performance of the major engine components is based on component maps. These maps are usually obtained from analytical methods or rig-testing and are then converted into Block Data subroutines for use by TRISPL. The maps presently included in TRISPL are very general and do not represent any particular engine or engine components.

The component maps are scaled at the engine design point by TRISPL in order to match their performance to a desired set of performance figures which are input as data. Scaling or correction factors are calculated and then applied to the maps at off-design points. The scaling process is linear; therefore, correction factors near unity result in the highest accuracy of component simulation. Conversely, however, not being close to 1.0 does not necessarily mean that the simulation is poor since many maps have been shown to be typical over quite large ranges in the variables.

TRISPL presently includes component maps for the fan, intermediate compressor, high pressure compressor, combustor, and the three turbines. Duct burning, duct losses, gas mixing, afterburning, tailpipe losses, and nozzle losses are all calculated or input, but these characteristics could also be included as Block Data if maps were available. Likewise, schedules for bleed air and variable area nozzles could be used.

a. Fan-Compressor Maps

The fan and compressor maps are very similar and are plots of pressure ratio vs. corrected airflow with constant corrected speed lines and constant efficiency islands (see Fig. 1). Entry to the map is through the corrected speed and Z, where Z is a ratio of pressure ratios, and is defined at a constant corrected speed as shown in Figure 1. It is advantageous to use Z instead of pressure ratio because Z is restrained between the limits of 0 and 1, whereas the limits on pressure ratio vary depending upon map location and the particular map. Also, as indication that the fan or a compressor is approaching surge is given as Z approaches 1.

b. Combustor Map

The combustor map is a plot of efficiency vs. temperature rise for constant input pressure (see Fig. 2). Entry to the map is through temperature rise and input pressure, with efficiency being output.

c. Turbine Maps

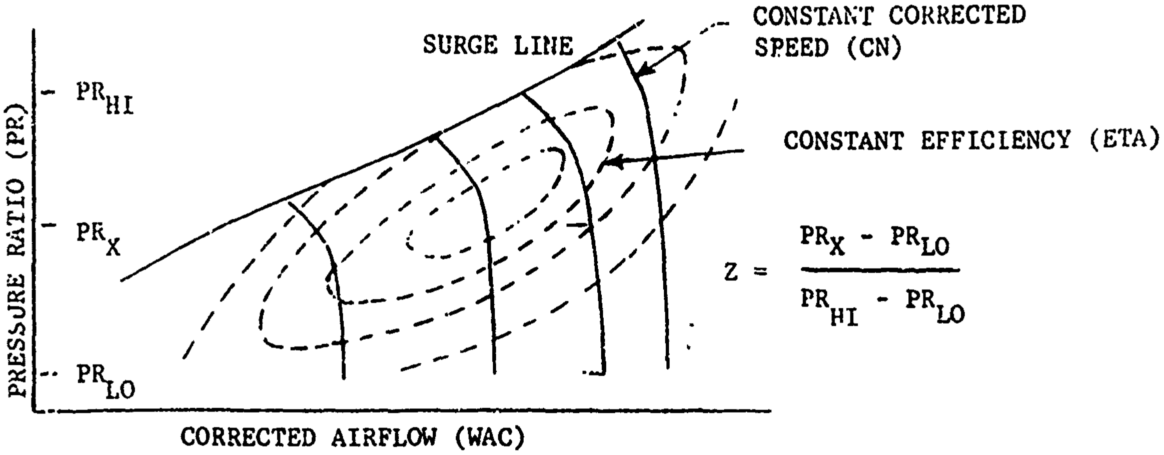
The turbine map is a plot of work function vs. corrected speed with constant turbine flow function lines and constant efficiency islands (see Fig. 3). The work function and flow function are defined as

$$DHTC = \frac{H_{IN} - H_{OUT}}{T_{IN}}$$

and

$$\frac{WG_{IN}\sqrt{T_{IN}}}{P_{IN}}$$

Entry to the map is through corrected speed and flow function, with work function and efficiency being output.



$$Z = \frac{PR_X - PR_{LO}}{PR_{HI} - PR_{LO}}$$

Figure 1. Example of Fan-Compressor Map

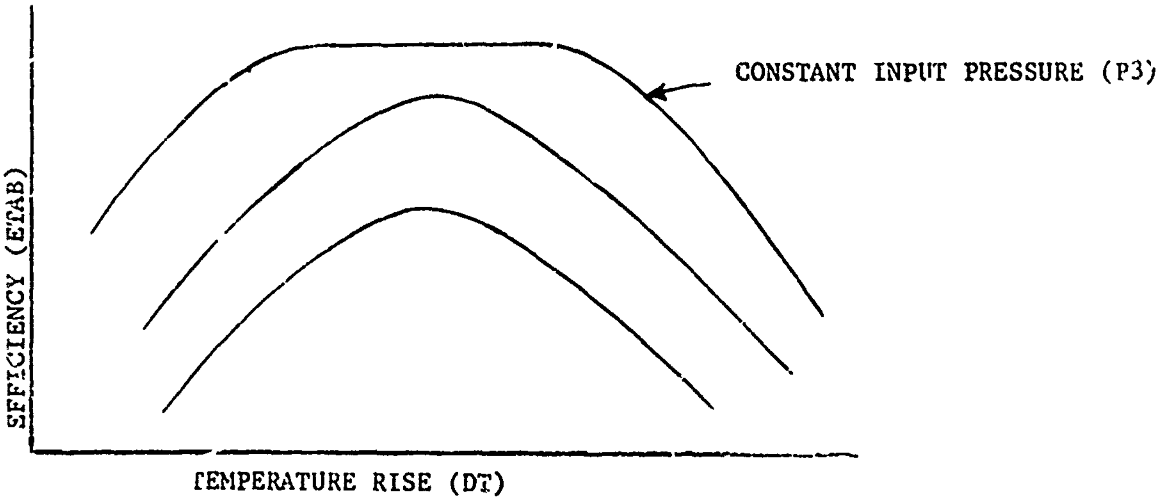


Figure 2. Example of Combustor Map

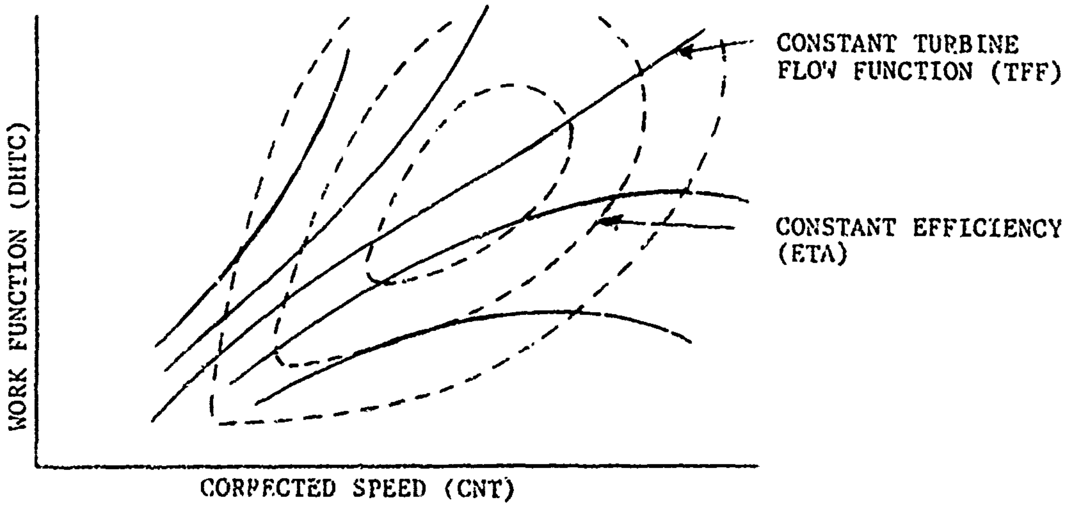


Figure 3. Example of Turbine Map

The work function could have been used as an entry in place of one of the present entries, but, because of the shape of the curves, this could lead to double entry points for one work function. However, if the turbine maps were plotted in a different format, this could be an acceptable method.

2. DESIGN POINT

Once the component maps have been reduced to Block Data form and placed in the program, it is necessary to run a design point. The design point is run at those conditions under which the real engine is designed or sized, often sea level static. Design parameters necessary to simulate the real engine (for example, airflow, bypass ratio, turbine inlet temperature, various pressure losses, pressure ratios, etc.) are input and a complete thermodynamic cycle calculation is performed. For more details on the cycle calculation see Section III 4, "Off-Design Points". Scale factors for the component maps are calculated to insure that the input design parameters are met. If the design parameters have been correctly input, the design point will be completed after one pass through the engine calculations (that is, no balancing will occur) because the maps are shifted to reduce the errors to zero.

Other parameters calculated and output at the design point include certain temperatures, airflows, gas mixing areas, and nozzle throat and exit areas.

3. SCALING FACTORS

Scaling or correction factors are calculated at the design point using the following equation:

P (correction factor) = P (design)/P (map)

where P represents a general parameter. One exception to this equation is the equation for calculating the fan and compressors pressure correction factors:

$$PR\ (\text{correction factor}) = \left[PR\ (\text{design}) - 1\right] / \left[PR\ (\text{map}) - 1\right]$$

where PR represents a general pressure ratio.

Theoretically, if the component maps and the input design parameters are exact representations of a particular engine, the correction factors will equal 1. However, this will not be true due to map interpolations, certain assumptions such as ideal and isentropic flow, and tolerances in the thermodynamic calculations. If unmatched component maps are used, the correction factors can differ significantly from 1.

4. OFF-DESIGN POINTS

The following discussion pertains particularly to off-design points, although the input and the general cycle calculations are the same for the design point. Throughout the following discussion, it should be remembered that scaling or correction factors (multipliers) are applied to all performance maps (Block Data parameters). A schematic diagram of the engine components and station designations is shown in Fig. 4.

a. Input

The program uses a controlled output; that is, the variables desired as output can be selected at the start of a run. This selection is obtained by placing the names of the variables in the first section of input cards. Controls, scaling factors and operating conditions make up the rest of the input.

The control inputs are used to determine the type of engine; mixed or separate flow, afterburning or duct burning, and convergent or convergent-divergent nozzle. The controls are also used to fix the

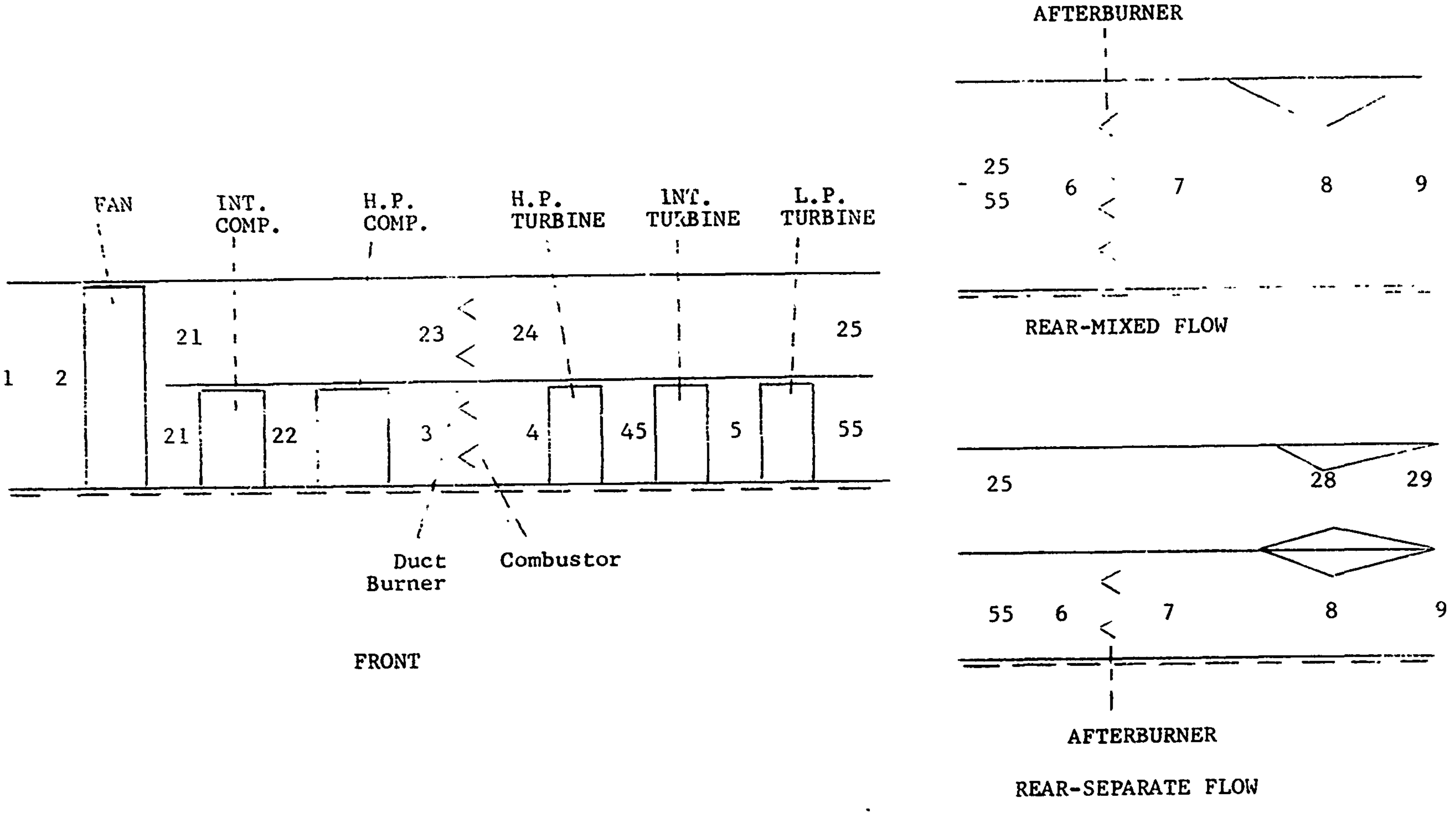


Figure 4. Schematic of Engine Components

mode of operation; constant PCNF, constant PCNC, constant T4, or constant WFB. Other controls determine inlet conditions, title printout, and cycle looping printouts. The correction factors can be input directly, or the design point can be run first and the calculated factors will be stored in common. The operating conditions include the flight Mach number, altitude, power setting (either PCNF, PCNC, T4, or WFB), duct burner and afterburner temperatures or fuel flows, bleed, and horsepower extraction.

b. Initial Values

The program uses six primary independent variables: ZF, PCNF, ZI, PCNI, ZC, PCNC (T4 may be substituted for PCNF or PCNC, depending upon the mode of operation). Three secondary independent variables (TFFHP, TFFIP, and TFFLP) are also used to ensure correct entry into the turbine maps. Initial values for these nine variables must be obtained to start the program at each point. A subroutine (GUESS) supplies these variables as a function of T2, T21, and some of the variables themselves. It is important to note that the closer the initial values are to the final values at a balanced point, the faster the program will run. Therefore, after a particular engine configuration has been run a few times, it is usually advisable to change the general initial value equations to suit the engine, using the knowledge gained from past runs to estimate more closely the final values of the variables.

c. Inlet

The thermodynamic properties of the atmosphere are found from a 1962 ARDC Atmosphere Tables subroutine. Using conservation of energy and isentropic flow, the conditions at the face of the fan can be found. A ram recovery can be input or, if not input, a ram recovery defined by MIL-E-5008E Specifications will be used. If desired, a T2-P2 direct input mode is available as are provisions for nonstandard day conditions.

d. Fan and Compressor

Block Data is used to determine the performance characteristics of the fan and compressors. When Z and PCN are known, the pressure ratio, corrected airflow and efficiency can be found by using a general Block Data interpolation routine named SEARCH. With the pressure ratio known and when the assumption of isentropic compression and the efficiency are used, the thermodynamic conditions at the exit of the fan and compressors can be calculated. Bleed for consumer use, leakage, or cooling is accounted for. Actual airflow leaving the fan and compressors is calculated from corrected airflow, temperature, pressure, and bleed.

It should be mentioned here that the present form of TRISPL calculates corrected speed (CN) in a manner slightly different from SMOTE. TRISPL uses an equation which forces corrected speed (CN) to equal physical shaft speed (PCN) at the design point. The equation is

$$CN = (PCN/\sqrt{\theta}) \cdot \sqrt{\theta_D}$$

where θ is corrected temperature, and θ_D is the corrected temperature at design. Thus, at the design point, CN = PCN. This equation is useful for studying theoretical engines where actual maps are not available but must be changed back to the SMOTE equation if real engines are to be simulated. SMOTE uses this equation: $CN = PCN/\sqrt{\theta}$.

e. Combustor

The pressure drop in the combustor is a function of a design pressure drop and ratio of corrected airflow to design corrected airflow. Combustor efficiency is obtained from Block Data using SEARCH. The fuel used is assumed to be JP-4 (at 59°F), and, with the assumption of adiabatic and constant pressure combustion, a fuel heating value equation as a function of T4 has been derived. Thus the fuel/air ratio, fuel flow, and thermodynamic conditions at the combustor exit can be calculated. If WFB is known instead of T4, a small iteration is necessary.

f. Turbines

The turbine subroutines all use similar logic and obtain their performance characteristics from Block Data using subroutine SEARCH. All three turbine parameters (CN, TFF, DHTC) can be calculated before entering the turbine map, but only two are needed. Therefore, the third parameter obtained from the map is compared with the calculated third parameter, and a balancing error is generated if they are not equal. In this program, CN and TFF are used for map entries, and DHTC is used to generate the error. In addition, the efficiency is also obtained through SEARCH.

In addition, another error will be generated if TFF is not within map limits. The error will be the difference between TFF and the nearest map limit. This error becomes particularly important when the estimated initial values of the independent variables are far from the correct values, and the point is extremely unbalanced. When either TFF or CN is not within map limits, they are set to the nearest map limit, and one of the independent variables is changed in an attempt to rectify the situation. The operating point must appear on all maps before a complete cycle calculation can be accomplished.

Horsepower extraction is accounted for in calculating DHTC of the high pressure turbine. When the efficiency is used and the turbine process is assumed isentropic, the thermodynamic properties at the three turbine exits can be calculated. Any bleed airflow for cooling the turbines is treated as if it entered the main stream behind the turbine, and the thermodynamic properties at the turbine exit are recalculated to account for this.

g. Duct

The duct airflow and bypass ratio are calculated from the fan and intermediate compressor airflows. The pressure drop in the duct is treated as in the main combustor. For duct burning, the same fuel heating value equation that was used in the main combustor is again used, but the efficiency must be input. As in the combustor, either the temperature (T24) or the fuel flow (WFD) may be input.

If a separate flow engine is being simulated, the duct nozzle calculations are done in this routine, although they are accomplished in the same manner as for the main nozzle.

h. Mixer

The gas mixing areas (duct exit and turbine discharge for a mixed flow engine or just the turbine discharge area for a separate flow engine) are calculated at the design point using either an input core static pressure or Mach number. In the mixed flow mode, there is an option for calculating afterburner entrance area as a function of an input afterburner entrance Mach number at the design point. At an off-design point the areas are used to calculate static pressures and Mach numbers.

For a separate flow engine, the thermodynamic conditions entering the afterburner are now known, since they are identical to turbine discharge conditions.

For a mixed flow engine, a set of derived equations based on one-dimensional fluid flow theory and conservation of mass, energy, and mementum is used to determine the thermodynamic conditions after complete mixing of the two gas streams. These equations do not require that the static pressures of the two entering streams be equal. However, for a correct engine balance, the two static pressures must be equal, and a balancing error is generated if they are not equal.

i. Afterburner

The dry loss (cold loss) pressure drop in the afterburner is a function of a design pressure drop and the ratio of corrected gas flow to the design corrected gas flow.

For afterburning, the same equation for the fuel heating value that was used in the combustor is again used, but the efficiency must be input. As in the combustor, either temperature (T2) or the fuel flow (WFA) may be input. A momentum loss (hot loss) pressure drop is also calculated.

j. Nozzle

The main nozzle program uses fixed effective areas (except when afterburning or when different nozzle areas are directly input) calculated at the design point. Either a convergent or convergent-divergent subroutine may be used depending upon the input controls. If afterburning has been selected, the nozzle areas are allowed to float to obtain optimum performance; however, the areas are returned to their original design values after the afterburning point is completed. Nozzle areas can also be changed by directly inputting different nozzle area values. The duct nozzle behaves identically to the main nozzle, including floating areas if duct-burning has been selected.

Because all thermodynamic properties of the gas stream are known, as well as the amount of flow, nozzle areas, and ambient pressure, there is a redundant parameter. For this program, the total pressure of the gas stream was chosen as the redundant parameter. The nozzle calculations are made without using the total pressure, and a required total pressure compatible with all other known parameters is calculated. This required pressure is compared with the actual pressure and a balancing error is generated if they are not equal.

k. Performance and Output

At this point, nine errors have been generated after one pass through the engine. Several more passes must be completed under control of the error matrix and engine balancing technique. See Section IV for a detailed description of the balancing technique. Eventually however, the errors will be reduced to zero, and engine performance will be calculated using standard equations. Gross thrust is obtained by summing the mementum term (a nozzle velocity coefficient may be input) and a pressure-area term, and the net thrust is in turn found by subtracting a ram drag (airflow momentum loss at inlet) term from the gross thrust. Specific fuel consumption (SFC) is total fuel flow divided by net thrust.

As previously mentioned, a controlled output is used, whereby only selected variables are printed. Each variable is labeled with its name and provisions have been made for changing the name of a variable. In addition, the values of all variables in common are printed in a close format so that variables other than those selected for a specific run are available later on.

5. QUADRATIC INTERPOLATION ROUTINE

Throughout the program there are many small loops (for example, thermodynamic iterations and table look-up) which require convergence. Trial-and-error methods and linear interpolations can be time consuming, especially when a tight tolerance is necessary; therefore, a general interpolation routine called AFQUIR (Air Force Quadratic Interpolation Routine) (Reference 1) is used.

This routine requires a dummy array dimensioned for nine locations. Also input into the routine through the calling argument are the independent and the dependent variables, the answer or value which the dependent variable is to converge upon, the number of tries at convergence, the tolerance, and a variable called DIR.

The DIR is either set or calculated in the calling program and is an initial guess at the direction and percentage change to apply to the first value of the independent variable. If not enough is known about the variable to calculate DIR, an arbitrary value may be set. This should not affect the final result, but may increase the number of tries of convergence.

The DIR thus establishes the second value at the independent variable. This value is used in the calling program to determine a corresponding second value of the dependent variable and AFQUIR is called a second time with two sets of values. A linear interpolation is made which results in a third value of the indepenuent variable. AFQUIR is then called a third time with the third values of the independent and dependent variables and a quadratic interpolation is made. The values of these three sets of variables have been stored in the dummy array, and from hereon, quadratic interpolations are made using the three sets which give values closest to the answer. Values farthest from the answer are lost.

Various safeguards are built into AFQUIR to return the interpolation method to DIR or linear if the roots of the quadratic become complex, if the quadratic does not intercept the answer, if the value of the independent variable differs radically from previous values, or if two sets of independent and dependent variables are identical.

Also it is possible to preload the dummy array directly at the linear or quadratic interpolations if desired.

In summary, AFQUIR is a completely flexible routine which performs quadratic interpolation for quick convergence of general functions.

SECTION IV

BALANCING TECHNIQUE

The balancing technique is virtually the same as that used in SMOTE. It is based on finding a solution for a set of partial differential equations. For this program, the set is composed of nine equations; however, using a set of only three equations will simplify the following discussion. This corresponds to a basic single spool turbojet simulation. SMOTE uses a set of six equations.

As discussed previously, nine independent variables (ZF, PCNF or T4, ZI, PCNI, ZC, PCNC or T4, TFFHP, TFFIP, and TFFLP) were selected. Once these variables have been given initial values, it is possible to proceed through an entire engine cycle calculation. Nine errors are generated as shown in Section III. These initial values of the nine variables and nine errors are referred to as base values.

In the following equations, V refers to a variable and E to an error. The basic set of differential equations based on E = f(V) is

$$dE_1 = \frac{\partial E}{\partial V_1}11 \; dV_1 + \frac{\partial E}{\partial V_2}12 \; dV_2 + \frac{\partial E}{\partial V_3}13 \; dV_3$$

$$dE_2 = \frac{\partial E}{\partial V_1}21 \; dV_1 + \frac{\partial E}{\partial V_2}22 \; dV_2 + \frac{\partial E}{\partial V_3}23 \; dV_3$$

$$dE_3 = \frac{\partial E}{\partial V_1}31 \; dV_1 + \frac{\partial E}{\partial V_2}32 \; dV_2 + \frac{\partial E}{\partial V_3}33 \; dV_3$$

where the single subscripts correspond to three variables and three errors and where the double subscripts indicate the change in a particular error (first subscript) due to a change in a particular variable (second subscript).

Assuming small changes result in the following approximations (where B refers to a base value):

$$dE = E - EB$$
$$dV = V - VB$$
$$\frac{\partial E}{\partial V} = \frac{\Delta E}{\Delta V}$$

With these approximations and the fact that E should be zero when the engine is balanced, the set of partial differential equations reduces to

$$E_1 - EB_1 = \frac{\Delta E_{11}}{\Delta V_1} dV_1 + \frac{\Delta E_{12}}{\Delta V_2} dV_2 + \frac{\Delta E_{13}}{\Delta V_3} dV_3 = - EB_1$$

$$E_2 - EB_2 = \frac{\Delta E_{21}}{\Delta V_1} dV_1 + \frac{\Delta E_{22}}{\Delta V_2} dV_2 + \frac{\Delta E_{23}}{\Delta V_3} dV_3 = - EB_2$$

$$E_3 - EB_3 = \frac{\Delta E_{31}}{\Delta V_1} dV_1 + \frac{\Delta E_{32}}{\Delta V_2} dV_2 + \frac{\Delta E_{33}}{\Delta V_3} dV_3 = - EB_3$$

Three more passes (nine for TRISPL) are now made through the engine cycle calculations, and one variable is changed by a small amount (ΔV) for each pass. The change in each error due to the small change in the variables (ΔE/ΔV) can be calculated.

The above set of differential equations can now be solved for dV_1, dV_2 and dV_3 and, in general, the new value of each independent variable would be given by

$$V = VB + dV$$

If the engine cycle calculations were linear functions, the engine would balance (errors equal zero) with these new values of the variables. However, this is usually not the case. The new errors become base errors (still keeping the old $\Delta E/\Delta V$'s) and another attempt at balance is performed. If several such attempts still fail, the entire process is repeated where the new errors and variables become base values and a new set of $\Delta E/\Delta V$'s are calculated.

A subroutine to determine the solution of a matrix is used to solve the set of differential equations. After each pass through the engine, a matrix array is loaded with the appropriate values; after ten passes (base value plus nine independent variables) the matrix subroutine is called to solve the matrix.

It was found that the "dV's" obtained from the solution of the differential equations were in many cases too large, thus causing the variables to exceed their limits, and to make it practically impossible to balance the cycle. The "dV's" are therefore multiplied by a suppression factor calculated in the program which limits the swing of the variables. Although this procedure may tend to increase the number of passes before balancing in some cases, it also balances points which previously would not balance. These points are most generally far from the design point, where oscillations of the dependent variables tend to build up.

SECTION V

INPUT/OUTPUT DESCRIPTIONS

1. BLOCK DATA INPUT

The three compressor maps are entered into the program as BLOCK DATA subprograms FANDAT, INTDAT, and CMPDAT.

Using FANDAT as an example (refer to program listing), and referring to typical map (Fig. 1), the data are programmed as follows:

Card 1 identifies the program as BLOCK DATA. Card 2 is a comment card. Card 3 identifies the common block FAN into which data are to be stored and dimensions the program variables. Card 4 indicates that there are 10 speed lines N and the number of points NP on each line (6 on the lowest speed, 7 on the next 3 lines, etc). Card 5 assigns the value of speed to each of the 10 lines (low to high). The remaining cards indicate the values of pressure ratio (PR), corrected airflow (WAC), and efficiency (ETA) for the speed lines. For example, the card

```
DATA (PR (4,J), J = 1,7)/
```

denotes that the pressure ratios are for the 4th speed line (CN = 0.6) and that there are 7 points.

The combustor BLOCK DATA subprogram is CMBDAT. Referring to the program listing and a typical combustor map (Fig 2), the data are programmed as follows:

Card 1 identifies the program as BLOCK DATA. Card 2 identifies the common block COMB into which data are to be stored and dimensions the variables. Card 3 indicates that there are 15 lines of constant PSI(P3) by the value of N, and that there are 15 values of DELT (DT) and ETA(ETAB) along each line of constant PSI(P3). Cards 4 and 5 assign values to each of the P3 lines from low to high pressure. Cards 6 to 8 assign values of ΔT to each of the P3 lines starting at low ΔT. The lowest value of ΔT on each of ΔT on the lowest value of P3. Next comes the second lowest value of ΔT on each P3, etc. Cards 9 to 16 assign the value of ETAB in a one-to-one correspondence with the ΔT values just assigned. The order is the same.

The turbine maps are the BLOCK DATA subprograms HTURB, ITURB, and LTURB. Taking HTURB as an example and referring to the program listing and a typical map (Fig.3) the data are programmed as follows: Card 1 identifies the subprogram as BLOCK DATA. Card 2 is a COMMENT card. Card 3 identifies the common block HTURB into which data are to be loaded and dimensions the program variables. Card 4 indicates the number of constant turbine flow function lines TFF as 11 (N) and the number of points on each line from low to high TFF. Cards 5 and 6 set values of TFF from low to high. The remaining cards set the values of corrected speed (CN), work function (DH), and efficiency (ETA) starting from low TFF. For example, the card,

```
DATA (DH(5,J), J = 1,15)/
```

denotes that the work functions are for the 5th flow function line (TFF = 49.175) and that there are 15 points.

2. CONTROLLED OUTPUT/NAMELIST INPUT

The input data is divided into two sections; data cards for the controlled output, and data cards in Namelist format for running each point. For the following discussion on setting up input data, refer to the listing of sample data immediately following the program listing.

a. Controlled Output

The variables that are to be output are selected by the first section of data cards. Any variable that is in one of the main commons (DESIGN, FRONT, SIDE, or BACK) may be selected for output by punching the name at the variable as it appears in the common (with trailing blanks if necessary) in Columns 1 through 7. Up to 150 variables (25 lines of 6 variables) may be chosen for a particular run. During the output phase, the name of the variable is printed out, with its value printed immediately below the name.

Another feature of the controlled output is the ability to change the name of a variable to be output; for example, it may be desired to change a station designation to one more common to a particular programmer. In this case, the variable name would be punched in Columns 1 through 7 as described above, but in addition, the desired name would be punched in Columns 15 through 22. Special symbols, such as /, may be used in the new name. The last card of the controlled output must be a card with THEEND punched in Columns 1 through 6.

In addition to the variables selected as controlled output, the values of all variables in common are printed in a close format so that variables other than those selected for a specific run are available later on.

b. NAMELIST Input

The normal data for running the desired points follows the controlled output data and is in a Namelist format, where the name of the Namelist is DATAIN. Usually the first set of data is the design point, as shown in the sample input data. When the design point is run (DDES = 1), all map scaling or correction factors are printed out, as well as being retained in common. Therefore, it is possible to run off-design points immediately following the design point by making use of the values in common, or to begin running an off-design point immediately by inputting the scaling or correction factors. The first method is usually easier, but the second method may be desired if many points are to be run using the same engine parameters with no changes except for power setting, Mach number, and altitude.

The variables that must be input at the design point for the basic cycle (for example, no afterburning) are listed in Table I below:

TABLE I

INPUTS REQUIRED FOR BASIC CYCLE AT DESIGN POINT

VARIABLE	DEFINITION	UNITS
PRFDS	Fan pressure ratio	
WAFDS	Fan face airflow	lb/sec
ETAFDS	Fan efficiency	
ZFDS	Design Z of fan	
PCNFDS	Fan shaft speed expressed as percent	
PRIDS	Intermediate compressor pressure ratio	
WAIDS	Intermediate compressor (core) airflow	lb/sec
ETAIDS	Intermediate compressor efficiency	
ZIDS	Design Z of intermediate compressor	
PCNIDS	Intermediate compressor shaft speed as a percent	
PRCDS	High pressure compressor pressure ratio	
ETACDS	High pressure compressor efficiency	
ZCDS	Design Z of high pressure compressor	
PCNCDS	High pressure compressor shaft speed as a percent	
ETABDS	Combustor efficiency	
DPCODS	Combustor pressure drop, $\Delta P/P$	
DTCODS	Combustor temperature rise	°R
T4DS	Turbine inlet temperature	°R
TFHPDS	High pressure turbine flow function	$lb\sqrt{^\circ R}/(SFC)(p$
CNHPDS	High pressure turbine corrected speed	
ETHPDS	High pressure turbine efficiency	
TFIPDS	Intermediate turbine flow function	$lb\sqrt{^\circ R}/(SFC)($

VARIABLE	DEFINITION	UNITS
CNIPDS	Intermediate turbine corrected speed	
ETIPDS	Intermediate turbine efficiency	
TFLPDS	Low pressure turbine flow function	lb$\sqrt{°R}$/(sec)(psia)
CNLPDS	Low pressure turbine corrected speed	
ETLPDS	Low pressure turbine efficiency	
DPDUDS	Fan duct pressure drop, $\Delta P/P$	
DPAFDS	Tailpipe pressure drop, $\Delta P/P$	
AM55 or	Mach number at low pressure turbine exit	
PS55	Static pressure at low pressure turbine exit	atm
AM	Flight Mach number	
ALTP	Altitude	ft
HPEXT	Horsepower extraction	hp
CVMNOZ	Main nozzle velocity coefficient	
CVDNOZ	Duct nozzle velocity coefficient	
	+	
	Various bleed flows (see Symbols)	
	+	
	Various control parameters (see below)	

As mentioned in Table I, various control parameters which fix the engine type, mode of operation, method of calculating ram recovery, etc. must be input. These are listed below. Subroutine ZERO determines what values in common will be zeroed between points. None of the design values or correction factors are zeroed but some of the control parameters are. In the control parameter listing below, the superscripts (1) to (4) have the following meanings: (1) automatically returned to zero after each point is calculated, must be re-input if option is again desired, (2) option can be used only at off-design points; (3) these input values remain as input unless changed by a new value; (4) a set-up case must be run where all the components are first matched before these $\neq 0$ options are used, then the identical case may be repeated exercising these options.

IDES = 1 (1)	For calculating design point
MODE = 0 (3)	Specify T4
(2) MODE = 1 (3)	Specify PCNC
MODE = 2 (3)	Specify WFB
(2)MODE = 3 (3)	Specify PCNF
INIT = 0 (3)	Initializes point
INIT = 1 (3)	Will not initialize point
IDUMP = 0 (3)	No looping write-outs
IDUMP = 1 (3)	Will dump looping write-outs if error occurs
IDUMP = 2 (3)	Will dump looping write-outs after every point
IAMTP = 0 (3)	Will use AM and mil-spec ETAR
IAMTP = 1 (3)	Will use input AM and input ETAR
IAMTP = 2 (3)	Will use input T2 as T1=T1+T2 and standard P1 (T2 value needs to be input at every point or an error will occur whenever used)
IAMTP =3 (3)	Will use input P2 and standard T1
IAMTP=4 (3)	Will use input T2 and input P2
IGASMX=0 (3)	Separate flow, A6=A55

IGASMX=1 (3)	Will mix duct and main streams, A6=A25+A55
IGASMX=2 (3)	Will mix duct and main streams, input AM6
(4) IDBURN=1 (1)	For duct burning, input T24
(4) IDBURN=2 (1)	For duct burning input WFD
(4) IAFTBN=1 (1)	For afterburning (mixed or unmixed streams), input T7
(4) IAFTBN=2 (1)	For afterburning (mixed or unmixed streams), input WFA
IDCD=1 (3)	FAn duct nozzle will be convergent-divergent
IMCD=1 (3)	Main nozzle will be convergent-divergent
(4) NOZFLT=1 (3)	For floating main nozzle exit area
(4) NOZFLT=2 (3)	For floating duct nozzle exit area
(4) NOZFLT=3 (3)	For floating duct and main nozzle exit areas
ITRYS=N	Number of passes through engine before quitting
TOLALL=X	Tolerance which the errors must satisfy before engine is matched
DELFG, DELFN, DELSFC	Normally input as 1.0 unless a correction is desired
ITITLE=1 (1)	A title card must follow after the input data for this point (see below)

A title card must be input immediately after the first point of the data pack and ITITLE must be set equal to 1 in the data for the first point. This is because a title is always printed for each point and must therefore be previously defined. The input format for the title is 12A6 and the resulting 72 spaces are centered on the page when printed out. The title may be changed by setting ITITLE=1 and inserting a new title card after the Namelist data for the point.

Off-Design Operation

Shown in the sample input listing are methods of specifying off-design operation points. The user inputs the appropriate control parameters, Mach number, altitude and power setting other than design values (power setting being a value for T4, PCNC, PCNF, or WFB).

If the engine has all its nozzles fixed, then an input such as T4 or shaft speed will set the thrust level. Other means of changing engine operation can be accomplished by varying nozzle throat areas A8 and A28. For example, an off-design condition may exist where the operating point lies outside the limits of the block data input for a component map such as the fan. A nozzle throat area change could return the operating point back on the input map. It should be noted that an area remains changed until it is recalculated by a new design case or altered by a new input.

The nozzle exit area (A9 and/or A29) may be floated to obtain full expansion of using NOZFLT=1, 2 or 3 for non-afterburning cases.

To run duct burning (fan stream only), cases load ETAD, and either T24 or WFD. To run afterburning, cases load ETAA, T7 or WFB. When such a point is run, the exhaust nozzle areas are allowed to float to obtain optimum expansion. This means that there can be no balancing at the point, and it is necessary to prebalance the engine cycle in a nonaugmented mode. That is, an identical point, except that it is nonaugmented must be run before either afterburning or duct burning. When either IAFTBN or IDBURN is greater than zero, the program will automatically set INIT=1 and use the balanced values from the preceding point. The nozzle areas are returned to their original values after completing an augmented point. Some examples of afterburning are given in the sample data listing.

SECTION VI

SUBROUTINE DESCRIPTIONS

A flow chart of the computer program with the subroutines is shown in Figure 5. Listed here are brief descriptions of the subroutines.

TRISPL — Dummy main program to initiate the calculations and cause the input of the controlled output variables. Because of the looping between subroutines, control is never transferred back to this routine.

ENGBAL — Main subroutine. Controls all engine balancing loops, checks tolerances and number of loops and loads matrix.

MATRIX — Solves error matrix

INPUT — Reads Namelist data and title. Prints title,

ZERO — Zeroes common and certain controls

COINLT — Determines ram recovery and performs inlet calculations

ATMOS — 1962 US Standard Atmosphere table

RAM — Calculates ram recovery defined by MIL-E-5008B Specifications

GUESS — Determines initial values of independent variables (PCNF, PCNI, PCNC, and T4) at each point. It may be desired to change these equations to suit a particular engine. The closer the initial values are to the final values, the faster the program will balance.

COFAN — Uses BLOCK DATA to perform fan calculations

COINTC — Uses BLOCK DATA to perform intermediate compressor calculations.

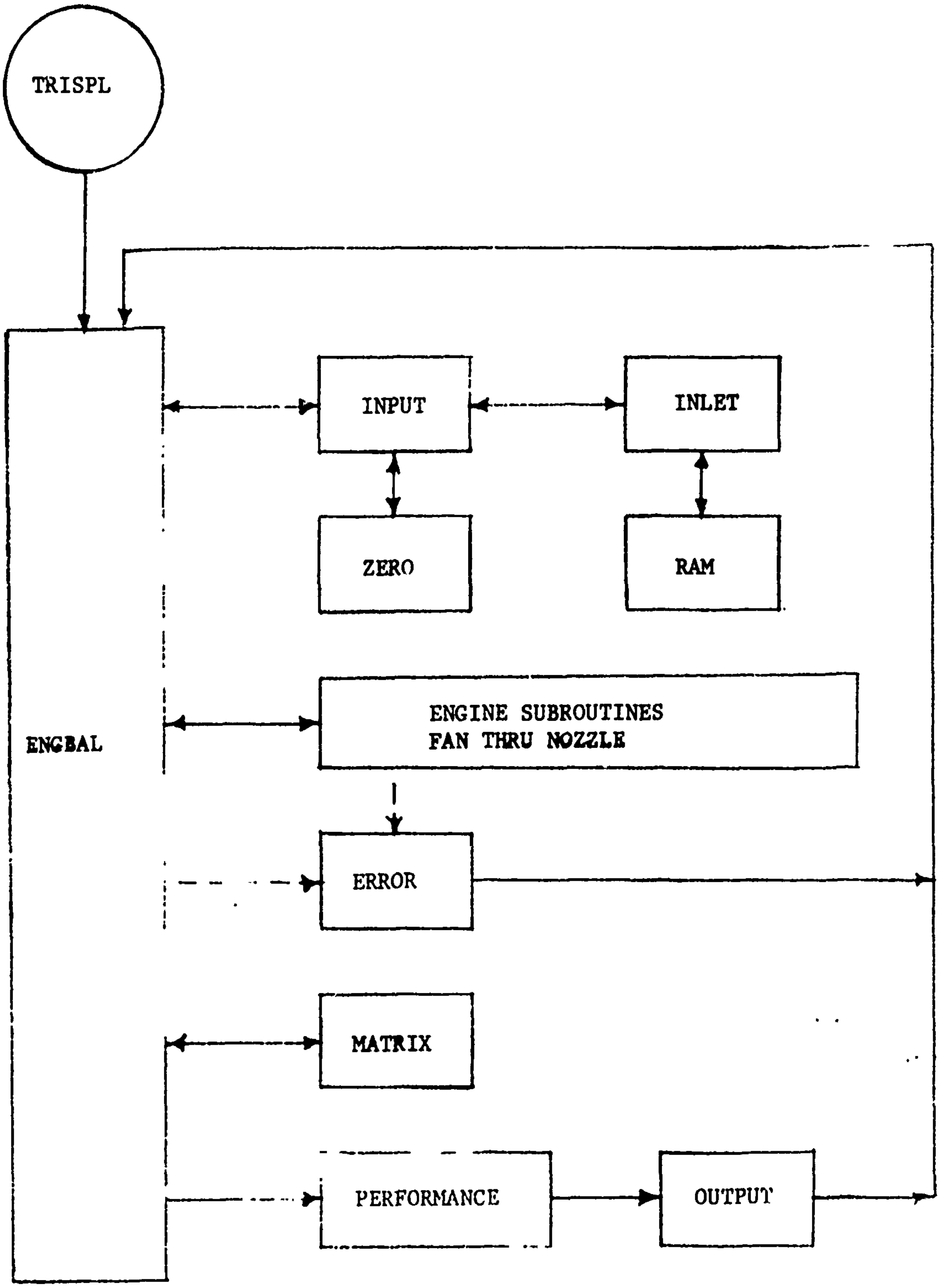


Figure 5. TRISPL Subroutine Flow Chart

COCOMP Uses BLOCK DATA to perform high-pressure compressor calculations. Calculates ERR(7).

COCOMB Uses BLOCK DATA to perform combustor calculations. May use either T4 or WFB as the main parameter.

COHPTB Uses BLOCK DATA to perform high-pressure turbine calculations. Calculates ERR(1) and ERR(2).

COIPTB Uses BLOCK DATA to perform intermediate turbine calculations. Calculates ERR(8) and ERR(9).

COLPTB Uses BLOCK DATA to perform low-pressure turbine calculations. Calculates ERR(3) and ERR(4).

FRTOSD Dummy routine to transfer values from common FRONT to common SIDE.

CODUCT Performs duct and duct-burning calculations. May use T24 or WFD as the main parameter for duct burning. Controls the duct nozzle and calculates ERR([illegible]) if in separate-flow mode.

FASTBK Dummy routine to transfer values from common FRONT and SIDE to common BACK.

COMIX Performs gas mixing calculations if in mixed flow mode. At design points it calculates areas from either an input static pressure (PS55) or an input Mach number (AM55) if PS55=0. Also, an option exists where afterburner entrance area A6 is calculated as a function of an input afterburner entrance Mach number AM6 at the design point. At off-design points it calculates static pressures and Mach numbers from the design areas. Calculates ERR(5) if in mixed-flow mode.

COAFBN Performs afterburning calculations. May use either T7 or WFA as the main parameter.

COMNOZ Controls the main nozzle and calculates ERR(6).

PERF Calculates performance after engine is balanced.

OUTPUT Prints output except for controlled output. Prints the main commons in a close format after each point.

CONCUT Controls and prints the controlled output variables.

ERROR Controls all printouts if an error occurs. Prints name of subroutine where error occurred and also prints the values of all variables in the main commons.

SYG Controls printing from UNIT08. Throughout the program and particularly in ENGBAL, certain messages, variables, and matrix values are written on UNIT08 as an aid in determining why an error occurred or why a point did not balance. These values are printed out if subroutine ERROR is called and IDUMP is greater than zero, or after a good point if IDUMP=2.

TAPES Defines UNIT08, which is just a "scratch" disk and does not require a $SETUP card. Normal input and output are on UNIT05 and UNIT06, respectively.

THCOMP Performs isentropic calculations for compressors.

THTURB Performs isentropic calculations for turbines.

THERMO Provides thermodynamic conditions using PROCOM.

PROCOM Calculates thermodynamic gas properties for either air or a fuel-air mixture, based on JP-4.

SEARCH General table lookup and interpolation routine to obtain data from Block Data routines.

MAPBAC Used when calculations result in values not on the turbine maps. Changes the map value and an independent variable (PCNF, PCNC or T4) in an attempt to rectify the situation.

CONVRG Performs nozzle calculations for a convergent nozzle.

CONDIV Performs nozzle calculations for a convergent-divergent nozzle.

AFQUIR General quadratic interpolation routine.

CMBDAT Block Data for combustors.

FANDAT Block Data for fan.

INTDAT Block Data for intermediate compressor.

CMPDAT Block Data for high-pressure compressor.

LTURB Block Data for low-pressure turbine.

ITURB Block Data for intermediate turbine.

HTURB Block Data for high-pressure turbine.

SECTION VII

PROGRAM LISTING

The following is a complete listing of all subroutines required to run TRISPL.

```
PROGRAM TRISPL(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE8)
COMMON /POINT/ICATPT
IDATPT=0
CALL CONOUT(1)
CALL ENGBAL
STOP
END
```

```
 SUBROUTINE ENGBAL
 COMMON /    ALL/
1WORD   ,IDES  ,JOES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
 COMMON/DESIGN/
1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  .
3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF
4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  .
5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF
6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS
7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS
8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  .
9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF
AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF
BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29
CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
 COMMON/ FRONT/
1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     .
5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU
6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    .
8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   .
ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF
BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI.
GPCBLLPC
 COMMON/  SIDE/
1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC ,
2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    .
5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
6WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  .
7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
 COMMON /  BACK/
XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
XXWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,
3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   -
8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
 DIMENSION DELSAV(9)
 DIMENSION VAR(9),DEL(9),ERRB(9),DELVAR(9),EMAT(9,9),VMAT(9),
     1AMAT(9)
      DATA DELSAV/9*.001/
      DATA AWORD/6HENGBAL/
      DATA VDELTA,VLIM,VCHNGE,NOMISX/
     1 0.001,0.100,0.850,4/
      DATA DEL/9*0./
      CALL INPUT
      IF(INIT.EQ.1) GO TO 50
      TFFHP=TFHPDS
      TFFIP=TFIPDS
      TFFLP=TFLPDS
50    LOOPER=0
      NUMMAP=0
      NOMISS=0
1     LOOP=0
      MISMAT=0
      NOMAP=0
      IGO=2
      DO 2 I=1,9
      VMAT(I)=0.
      AMAT(I)=0.
      DELVAR(I)=0.
      DO 2 L=1,9
2     EMAT(I,L)=0.
3     LOOPER=LOOPER+1
      CALL COFAN
      WORD=AWORD
      IF(LOOPER.GT.ITRYS) GO TO 20
      IF(NOMAP.GT.0) GO TO 1
      NUMMAP=0
55    VAR(1)=ZF*100.
      IF(MODE.NE.3) VAR(2)=PCNF
      IF(MODE.EQ.3) VAR(2)=T4/10.
      VAR(3)=ZC*100.
      IF(MODE.NE.1) VAR(4)=PCNC
      IF(MODE.EQ.1) VAR(4)=T4/10.
      VAR(5)=TFFHP
      VAR(6)=TFFLP
      VAR(7)=ZI*100.
      VAR(8)=PCNI
      VAR(9)=TFFIP
      DO 4 I=1,9
      IF(ABS(ERR(I)).GT.TOLALL) GO TO 5
    4 CONTINUE
      CALL PERF
      CALL ERROR
5     IF(LOOP.GT.0) GO TO 7
      MAPEDG=0
      MAPSET=0
      DO 6 I=1,9
      ERRB(I)=ERR(I)
6     DEL(I)=VDELTA*VAR(I)
      GO TO 9
7     IF(MISMAT.GT.0) GO TO 30
      IF(MAPEDG.EQ.0) GO TO 70
      MAPEDG=0
      MAPSET=1
      VAR(LOOP)=VAR(LOOP)+2.*DEL(LOOP)
      GO TO 10
70    IF(MAPSET.EQ.0) VAR(LOOP)=VAR(LOOP)+DEL(LOOP)
      IF(MAPSET.EQ.1) VAR(LOOP)=VAR(LOOP)-DEL(LOOP)
      MAPSET=0
      DO 8 I=1,9
      IF(DEL(LOOP).NE.0.) DELSAV(LOOP)=DEL(LOOP)
      IF(DEL(LOOP).EQ.0.) DEL(LOOP)=DELSAV(LOOP)
8     EMAT(I,LOOP)=(ERRB(I)-ERR(I))/DEL(LOOP)
9     LOOP=LOOP+1
      IF(LOOP.GT.9) GO TO 11
      VAR(LOOP)=VAR(LOOP)-DEL(LOOP)
10    ZF=VAR(1)/100.
      IF(MODE.NE.3) PCNF=VAR(2)
      IF(MODE.EQ.3) T4=VAR(2)*10.
      ZC=VAR(3)/100.
      IF(MODE.NE.1) PCNC=VAR(4)
      IF(MODE.EQ.1) T4=VAR(4)*10.
      TFFHP=VAR(5)
      TFFLP=VAR(6)
      ZI=VAR(7)/100.
      PCNI=VAR(8)
      TFFIP=VAR(9)
      IF(ZF.LT.0.) ZF=0.05
      IF(ZI.LT.0.) ZI=0.05
      IF(ZC.LT.0.) ZC=0.05
      GO TO (1,3),IGO
 11   DO 12 I=1,9
12    AMAT(I)=-ERRB(I)
      DO 14 I=1,9
      IZERO=0
      DO 13 LOOP=1,9
13    IF(EMAT(I,LOOP).EQ.0.) IZERO=IZERO+1
      IF(IZERO.LT.9) GO TO 14
      WRITE(6,100)I
      LOOPER=ITRYS+100
      GO TO 20
14    CONTINUE
      DO 16 LOOP=1,9
      IZERO=0
      DO 15 I=1,9
15    IF(EMAT(I,LOOP).EQ.0.) IZERO=IZERO+1
      IF(IZERO.LT.9) GO TO 16
      WRITE(6,101)LOOP
      LOOPER=ITRYS+100
      GO TO 20
16    CONTINUE
17    CALL MATRIX(EMAT,VMAT,AMAT)
      LBIG=0
      VARBIG=0.0
      DO 18 L=1,9
      ABSVAR=ABS(VMAT(L))
      IF(ABSVAR.LE.VLIM*VAR(L)) GO TO 18
      IF(ABSVAR.LE.VARBIG) GO TO 18
      LBIG=L
      VARBIG=ABSVAR
18    CONTINUE
      VRATIO=1.0
      IF(LBIG.GT.0) VRATIO=VLIM*VAR(LBIG)/VARBIG
      ERRAVE=0.0
      VMTAVE=0.0
      DELAVE=0.0
      DO 19 L=1,9
      DELVAR(L)=VRATIO*VMAT(L)
      ERRAVE=ERRAVE+ABS(AMAT(L))
      VMTAVE=VMTAVE+ABS(VMAT(L))
      DELAVE=DELAVE+ABS(DELVAR(L))
19    VAR(L)=VAR(L)+DELVAR(L)
      ERRAVE=ERRAVE/9.
      VMTAVE=VMTAVE/9.
      DELAVE=DELAVE/9.
      IF(MISMAT.GT.0) GO TO 32
      IF(NOMISS.EQ.0) MISMAT=1
      IF(MISMAT.EQ.0) IGO=1
20    WRITE(8,102) LOOPER
      DO 21 I=1,9
 21   WRITE(8,103) AMAT(I),(EMAT(I,L),L=1,9),VMAT(I),DELVAR(I),VAR(I)
      WRITE(8,104) ERRAVE,VMTAVE,DELAVE
22    IF(LOOPER.LT.ITRYS) GO TO 10
      CALL ERROR
      RETURN
30    VMTAVX=VMTAVE
      DO 31 I=1,9
31    AMAT(I)=-ERR(I)
      GO TO 17
32    WRITE(8,105) AMAT,ERRAVE,DELVAR,DELAVE,VMAT,VMTAVE,VAR
      MISMAT=MISMAT+1
      IF(VMTAVE.LT.VCHNGE*VMTAVX) GO TO 22
      WRITE(8,106)
      IF(MISMAT.LT.NOMISX) NOMISS=1
      MISMAT=0
      LOOP=0
      IGO=2
      GO TO 55
100   FORMAT(4H0ROW,I2,16H IS ZERO IN EMAT)
101   FORMAT(7H0COLUMN,I2,16H IS ZERO IN EMAT)
 102  FORMAT(7H0  ERRB,31X23HERROR MATRIX AFTER LOOP,I4,31X4HVMAT,
     16X6H0ELVAR,7X10HVARIABLE$$)
 103  FORMAT(1H0,F7.3,9F9.3,4XF9.3,3XF10.4,4XF11.4)
104   FORMAT(1H0,F8.4,32X14HAVERAGE VALLES,31X,2F11.4,5H$$$$$)
 105  FORMAT(12H0-----  AMAT,10F11.6,6H$$$$$$,
     1/,      12H -----DELVAR,10F11.6,6H$$$$$$,
     2/,      12H -----  VMAT,10F11.6,6H$$$$$$,
     3/,      12H -----   VAR,9F11.6,6H$$$$$$)
106   FORMAT(1H0,56X22HCHANGE TOO SMALL$$$$$$)
      END
      SUBROUTINE INPUT
      DIMENSION TITLE(12)
      COMMON /POINT/IDATPT
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFODS  ,DTOUDS ,ETADDS ,WA23CS ,DPDUOS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRCNT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC ,
     2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
     6WAD    ,WFC    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      COMMON /  BACK/
     XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
     XXWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
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      NAMELIST/DATAIN/ IENO,
     AITITLE ,IDES    ,MODE    ,INIT    ,ICUMP   ,IAMTP   ,IGASMX ,
     BIDBURN ,IAFTBN  ,IDCO    ,IMCO    ,NCZFLT  ,ITRYS   ,TOLALL ,
     CZFDS   ,PCNFDS  ,PRFDS   ,ETAFDS  ,WAFDS   ,PRFCF   ,ETAFCF  ,WAFCF   ,
     DZIDS   ,PCNIDS  ,PRIDS   ,ETAIDS  ,WAIDS   ,PRICF   ,ETAICF  ,WAICF   ,
     EZCDS   ,PCNCDS  ,PRCDS   ,ETACDS  ,         PRCCF   ,ETACCF  ,WACCF   ,
     FT4DS   ,WFBDS   ,DTCODS  ,ETABDS  ,WA3CDS  ,DPCODS  ,DTCOCF  ,ETABCF  ,
     GTFHPDS ,CNHPDS  ,ETHPDS  ,TFHPCF  ,CNHPCF  ,ETHPCF  ,DHHPCF  ,T2DS    ,
     HTFIPDS ,CNIPDS  ,ETIPDS  ,TFIPCF  ,CNIPCF  ,ETIPCF  ,DHIPCF  ,T21DS   ,
     ITFLPCS ,CNLPCS  ,ETLPDS  ,TFLPCF  ,CNLPCF  ,ETLPCF  ,DHLPCF  ,T22DS   ,
     JT24DS  ,WFDDS   ,DTDUDS  ,ETADDS  ,WA23DS  ,DPDUDS  ,DTDUCF  ,ETADCF  ,
     KT7DS   ,WFADS   ,DTAFDS  ,ETAADS  ,WG6CDS  ,DPAFDS  ,DTAFCF  ,ETAACF  ,
     LA55    ,A25     ,A6      ,A7      ,A8      ,A9      ,A28     ,A29     ,
     MT2     ,P2      ,T4      ,ZF      ,PCNF    ,ZI      ,ZC      ,PCNC    ,
     NWFB    ,TFFHP   ,TFFIP   ,TFFLP   ,AM      ,ALTP    ,ETAR    ,HPEXT   ,
     OPCBLF  ,BLF     ,PCBLI   ,BLI     ,PCBLC   ,BLC     ,PCBLDUI,PCBLDUC,
     PBLDUI  ,BLDUC   ,PCBLOBI,PCBLOBC,BLOBI   ,BLOBC   ,PCBLHPI,PCBLHPC,
     QPCBLIPI,PCBLIPC,PCBLLPI,PCBLLPC,BLHPI   ,BLHPC   ,BLIPI   ,BLIPC   ,
     RBLLPI  ,BLLPC   ,PS55    ,AM55    ,AM6     ,T24     ,ETAD    ,WFD     ,
     ST7     ,ETAA    ,WFA     ,CVDNOZ  ,CVMNOZ  ,DELFG   ,DELFN   ,DELSFC
      DATA IEND/0/
C *** ITITLE=1  WILL READ IN TITLE
C *** IDES  =1  FOR CALCULATING DESIGN POINT
C *** MODE  =0  FOR CONSTANT T4
C *** MODE  =1  FOR CONSTANT PCNC
C *** MODE  =2  FOR CONSTANT WFB
C *** MODE  =3  FOR CONSTANT PCNF
C *** INIT  =1  WILL NOT INITIALIZE POINT
C *** IDUMP =1  WILL DUMP LOOPING WRITE-OUTS IF ERRCR OCCURS
C *** IDUMP =2  WILL DUMP LOOPING WRITE-OUTS AFTER EVERY POINT
C *** IAMTP =0  WILL USE INPUT AM AND MIL SPEC ETAR
C *** IAMTP =1  WILL USE INPUT AM AND INPUT ETAR
C *** IAMTP =2  WILL USE T2 AS T1=T1+T2 AND STANDARD P1
C *** IAMTP =3  WILL USE P2 AND STANDARD T1
C *** IAMTP =4  WILL USE T2 AND P2
C *** IGASMX=0  SEPARATE FLOW, A6=A55
C *** IGASMX=1  WILL MIX DUCT AND MAIN STREAMS, A6=A25+A55
C *** IGASMX=2  WILL MIX DUCT AND MAIN STREAMS,INPUT AM6
C *** IDBURN=1  FOR DUCT BURNING, INPUT T24
C *** IDBURN=2  FOR DUCT BURNING, INPUT WFD
C *** IAFTBN=1  FOR AFTERBURNING, INPUT T7
C *** IAFTBN=2  FOR AFTERBURNING, INPUT WFA
C *** IDCO  =1  CUCT NOZZLE WILL BE C-D
C *** IMCD  =1  MAIN NOZZLE WILL BE C-D
C *** NOZFLT=1  FOR FLOATING MAIN NOZZLE
C *** NOZFLT=2  FOR FLOATING DUCT NOZZLE
C *** NOZFLT=3  FOR FLOATING MAIN AND DUCT NOZZLES
C *** ITRYS =N  NUMBER OF PASSES THRU ENGINE BEFORE QUITTING
      DATA AWORD/6H INPUT/
      IDATPT=IDATPT+1
      CALL ZERO
      WORD=AWORD
      READ(5,DATAIN)
      IF(IEND.NE.0) STOP
      CALL REMARK(14HNEW DATA POINT)
      IF(IAFTBN.GT.0.OR.IDBURN.GT.0) INIT=1
      IF(ITITLE.EQ.1) READ(5,101) TITLE
      ITITLE=0
      WRITE(6,102) TITLE
      IF(MODE.EQ.0) WRITE(8,103) IDES,AM,ALTP,T4   ,T24,T7
      IF(MODE.EQ.1) WRITE(8,104) IDES,AM,ALTP,PCNC,T24,T7
      IF(MODE.EQ.2) WRITE(8,105) IDES,AM,ALTP,WFB ,T24,T7
      IF(MODE.EQ.3) WRITE(8,106) IDES,AM.ALTP,PCNF,T24,T7
      CALL COINLT
      RETURN
  101 FORMAT(12A6)
  102 FORMAT(1H1,30X12A6)
  103 FORMAT(1H0,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,
     16X7H    T4=,F8.2,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)
  104 FORMAT(1H0,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,
     16X7H  PCNC=,F8.3,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)
  105 FORMAT(1H0,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,
     16X7H   WFB=,F8.4,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)
  106 FORMAT(1H0,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,
     16X7H  PCNF=,F8.3,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)
      END
      SUBROUTINE ZERO
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWF8    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLCBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC ,
     2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
     6WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      COMMON /  BACK/
     XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
     XXWF8  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      DIMENSION Z1(94),Z2(56),Z3(72)
      EQUIVALENCE (Z1(1),T1),(Z2(1),XP1),(Z3(1),XT55)
      DATA ISTART/0/
      ISTART=ISTART+1
      IDES=0
      JDES=0
      INIT=0
      IDBURN=0
      IAFTBN=0
      IDSHOC=3
      IMSHOC=3
      IF(ISTART.NE.1) GO TO 4
C***  ZERO FRONT,SIDE,AND BACK INITIALLY TO PREVENT CDC 6600 MODE ERRORS
      DO 5 I=1,94
    5 Z1(I)=0.
```

```
      DO 6 I=1,56
    6 Z2(I)=0.
      DO 7 I=1,72
    7 Z3(I)=0.
      CALL SYG(1)
      RETURN
    4 CONTINUE
      T2Q=T2
      F2Q=P2
      T4Q=T4
      DO 1 I=1,94
1     Z1(I)=0.
      DO 2 I=1,56
2     Z2(I)=0.
      DO 3 I=1,72
3     Z3(I)=0.
      T2=T2Q
      P2=P2Q
      T4=T4Q
      CALL SYG(1)
      RETURN
      END
```

```
       SUBROUTINE CCINLT
       COMMON /   ALL/
      1WORD  ,IDES   ,JDES   ,KDES   ,MODE   ,INIT   ,IDUMP ,IAMTP ,
      2IGASMX,IDBURN,IAFTBN,IDCD   ,IMCD   ,IDSHOC,IMSHOC,NOZFLT,
      3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
       COMMON/DESIGN/
      1PCNFGU ,PCNIGU ,PCNCGU ,T4GU    ,DUMD1   ,DELFG   ,DELFN   ,DELSFC ,
      2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS  ,WAFDS   ,PRFCF   ,ETAFCF  ,WAFCF  ,
      3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS  ,WAIDS   ,PRICF   ,ETAICF  ,WAICF  ,
      4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS  ,WACDS   ,PRCCF   ,ETACCF  ,WACCF  ,
      5T4DS   ,WFBDS  ,DTCODS ,ETABDS  ,WA3CDS  ,DPCODS  ,DTCOCF  ,ETABCF ,
      6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF  ,CNHPCF  ,ETHPCF  ,DHHPCF  ,T2DS   ,
      7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF  ,CNIPCF  ,ETIPCF  ,DHIPCF  ,T21DS  ,
      8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF  ,CNLPCF  ,ETLPCF  ,DHLPCF  ,T22DS  ,
      9T24DS  ,WFDDS  ,DTDUDS ,ETADDS  ,WA23DS  ,DPDUDS  ,DTDUCF  ,ETADCF ,
      AT7DS   ,WFADS  ,DTAFDS ,ETAADS  ,WG6CDS  ,DPAFDS  ,DTAFCF  ,ETAACF ,
      BA55    ,A25    ,A6     ,A7      ,A8      ,A9      ,A28     ,A29    ,
      CPS55   ,AM55   ,CVDNOZ ,CVMNOZ  ,A8SAV   ,A9SAV   ,A28SAV  ,A29SAV
       COMMON/ FRCNT/
      1T1     ,P1     ,H1     ,S1      ,T2      ,P2      ,H2      ,S2     ,
      2T21    ,P21    ,H21    ,S21     ,T22     ,P22     ,H22     ,S22    ,
      3T3     ,P3     ,H3     ,S3      ,T4      ,P4      ,H4      ,S4     ,
      4T45    ,P45    ,H45    ,S45     ,T5      ,P5      ,H5      ,S5     ,
      5T55    ,P55    ,H55    ,S55     ,BLF     ,BLI     ,BLC     ,BLDU   ,
      6CNF    ,PRF    ,ETAF   ,WAFC    ,WAF     ,BLDUI   ,BLDUC   ,BLOB   ,
      7CNI    ,PRI    ,ETAI   ,WAIC    ,WAI     ,BLOBI   ,BLOBC   ,WA3    ,
      8CNC    ,PRC    ,ETAC   ,WACC    ,WAC     ,ETAB    ,DPCOM   ,WG4    ,
      9CNHP   ,ETATHP ,DHTCHP ,DHTC    ,BLHP    ,BLHPI   ,BLHPC   ,FAR4   ,
      ACNIP   ,ETATIP ,DHTCIP ,DHTI    ,BLIP    ,BLIPI   ,BLIPC   ,DUMF   ,
      BCNLP   ,ETATLP ,DHTCLP ,DHTL    ,BLLP    ,BLLPI   ,BLLPC   ,CS     ,
      CWG45   ,FAR45  ,WG5    ,FAR5    ,WG55    ,FAR55   ,HPEXT   ,AM     ,
      DALTP   ,ETAR   ,ZF     ,PCNF    ,ZI      ,PCNI    ,ZC      ,PCNC   ,
      EWF8    ,TFFHP  ,TFFIP  ,TFFLP   ,PCBLF   ,PCBLI   ,PCBLC   ,PCBLDUI,
      FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
      GPCBLLPC
       DATA AWORD/6HCOINLT/
       WORD=AWORD
       AJ=778.26
       G=32.174049
       ALT=ALTP*2.0855531E+07/(2.0855531E+07-ALTP)
       CALL ATMOS(ALT,T1,XX1,XX2,XX3,P1,CS,XX4,IIER)
       IF(IAMTP.EQ.2) T1=T1+T2
 1     IF(IAMTP.NE.1) CALL RAM(AM,ETAR)
       FAR=0.0
       CALL FROCOM(FAR,T1,CS,XX2,XX3,R1,PHI1,H1)
       S1=PHI1-R1*ALOG(P1)
       H2=H1+(AM*CS)**2/(2.*AJ*G)
       P2T=1.
       DO 2 I=1,10
       CALL THERMO(P2T,H2,T2T,S2T,AW,0,0.0,1)
       IF(ABS(S2T-S1).LE.0.0001*S1) GO TO 3
 2     P2T=P1*EXP((AW/1.986375)*((S2T-S1)+(1.986375/AW)*ALOG(P2T/P1)))
       CALL ERROR
       RETURN
 3     IF(IAMTP.EQ.3.OR.IAMTP.EQ.4) ETAR=P2/P2T
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```
      P2=ETAR*P2T
      IF(IAMTP.NE.4) CALL THERMO(P2,H2,T2,S2,XX5,C,0.0,1)
      IF(IAMTP.EQ.4) CALL THERMO(P2,H2,T2,S2,XX5,0,0.0,0)
      IF(INIT.EQ.1) GO TO 6
      IF(IDES.EQ.1) GO TO 4
      IF(MODE.EQ.3) GO TO 5
      PCNF=GUESS(MODE,T4,T4DS,PCNC,PCNCDS,WFB,WFBDS,T2,T2DS,PCNFDS)
      PCNFGU=PCNF
      GO TO 5
 4    PCNF=PCNFDS
      PCNFGU=PCNF
      T2DS=T2
 5    ZF=ZFDS
 6    RETURN
      END
      SUBROUTINE ATMOS (ZFT, TM, SIGMA, RHO, THETA, DELTA, CA, AMU, K)
C   THIS IS A SUBROUTINE TO COMPUTE CERTAIN ELEMENTS OF THE 1962
C   U.S. STANDARD ATMOSPHERE UP TO 90 KILOMETERS.
C    CALLING SEQUENCE...
C
C    CALL ATMOS (ZFT, TM, SIGMA, RHO, THETA, DELTA, CA, AMU, K)
C         ZFT    =   GEOMETRIC ALTITUDE (FEET)
C         TM     =   MOLECULAR SCALE TEMPERATURE (DEGREES RANKINE)
C         SIGMA =    RATIO OF DENSITY TO THAT AT SEA LEVEL
C         RHO    =   DENSITY (LB-SEC**2-FT**(-4)   OR   SLUGS-FT**3)
C         THETA =    RATIO OF TEMPERATURE TO THAT AT SEA LEVEL
C         DELTA =    RATIO OF PRESSURE TO THAT AT SEA LEVEL
C         CA     =   SPEED OF SOUND (FT/SEC)
C         AMU    =   VISCOSITY COEFFICIENT (LB-SEC/FT**2)
C
C         K = 1 NORMAL
C           = 2 ALTITUDE LESS THAN -5000 METERS OR GREATER THAN 90 KM
C           = 3 FLOATING POINT OVERFLOW
C
C   ALL DATA AND FUNDAMENTAL CONSTANTS ARE IN THE METRIC SYSTEM AS
C   THESE QUANTITIES ARE DEFINED AS EXACT IN THIS SYSTEM.
C
C   THE RADIUS OF THE EARTH (REFT59) IS THE VALUE ASSOCIATED WITH THE
C   1959 ARDC ATMOSPHERE SO THAT PROGRAMS CURRENTLY USING THE LIBRARY
C   ROUTINE WILL NOT REQUIRE ALTERATION TO USE THIS ROUTINE.
      DIMENSION HB(10),TMB(10),DELTAB(10),ALM(10)
      DATA(HB(I),I=1,10)/-5.,0.,11.,20.,32.,47.,52.,61.,79.,88.743/
      DATA(TMB(I),I=1,10)/320.65,288.15,216.65,216.65,228.65,270.65,
     1 270.65,252.65,180.65,180.65/
      DATA(DELTAB(I),I=1,10)/1.75363,1.,2.23361E-01,5.40328E-02,
     1 8.56663E-03,1.09455E-03,5.82289E-04,1.79718E-04,1.0241E-05,
     2 1.6223E-06/
      DATA(ALM(I),I=1,10)/-6.5,-6.5,0.,1.,2.8,0.,-2.,-4.,0.,0./
      DATA  REFT59/2.0855531E 07/, GZ    /9.80665/,
     A      AMZ   /28.9644      /, RSTAR /8.31432/,
     B      FTTOKM/3.048E-04    /, S     /110.4  /,
     C      AMUZ  /1.2024E-05   /, CAZ   /1116.45/,
     D      RHOZ  /0.076474     /, GZENG /32.1741/
C  CONVERT GEOMETRIC ALTITUDE TO GEOPOTENTIAL ALTITUDE
      HFT = (REFT59/(REFT59+ZFT))*ZFT
C  CONVERT HFT AND ZFT TO KILOMETERS
      Z = FTTOKM*ZFT
      H = FTTOKM*HFT
      K = 1
      TMZ = TMB(2)
      IF (H.LT.-5.0.OR.Z.GT.90.0)  GO TO 16
      DO 10 M=1,10
      IF (H-HB(M)) 11,12,10
   10 CONTINUE
      GO TO 16
   11 M = M-1
   12 DELH = H-HB(M)
      IF (ALM(M).EQ.0.0)  GO TO 13
      TMK = TMB(M)+ALM(M)*DELH
C  GRADIENT IS NON ZERO, PAGE 10, EQUATION I.2.10-(3)
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      DELTA = DELTAB(M)*((TMB(M)/TMK)**(GZ*AMZ/(RSTAR*ALM(M))))
      GO TO 14
   13 TMK = TMB(M)
C  GRADIENT IS ZERO, PAGE 10, EQUATION I.2.10-(4)
      DELTA = DELTAB(M)*EXP(-GZ*AMZ*DELH/(RSTAR*TMB(M)))
   14 THETA = TMK/TMZ
      SIGMA = DELTA/THETA
      ALPHA = SQRT(THETA**3)*((TMZ+S)/(TMK+S))
C  CONVERSION TO ENGLISH UNITS
      TM = 1.8*TMK
      RHO = RHOZ*SIGMA/GZENG
      CA = CAZ*SQRT(THETA)
      AMU = AMUZ*ALPHA/GZENG
C     CALL OVERFL(J)
      J=2
        GO TO (15,17), J
   15 K = K+2
      GO TO 17
   16 K = 2
   17 RETURN
      END
      SUBROUTINE COFAN
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRCNT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON /   FAN/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),
     1NCN,NPT(15)
      DIMENSION WLH(2)
      DATA AWORD,WLH/6H COFAN,6H (LO) ,6H (HI) /
      WORD=AWORD
      THETA=SQRT(T2/518.668)
      IF(IDES.NE.1) GO TO 10
      THETAD=THETA
   10 CNF=PCNF*THETAD/(100.*THETA)
      IF(ZF.LT.0.) ZF=0.
      IF(ZF.GT.1.) ZF=1.
      CNFS=CNF
      CALL SEARCH(ZF,CNF,PRF,WAFC,ETAF,
     1CNX(1),NCN,PRX(1,1),WACX(1,1),ETAX(1,1),NPT(1),15,15,IGO)
      IF((CNF-CNFS).GT.0.0005*CNF) MAPEDG=1
      IF(IGO.EQ.1.OR.IGO.EQ.2) WRITE(6,1000) CNFS,WLH(IGO)
 1000 FORMAT(19H0* * *  CNF OFF MAP,F10.4,2XA6,11H* * *$$$$$$)
      WAF=WAFC*P2/THETA
      IF(IDES.NE.1) GO TO 1
      PRFCF=(PRFDS-1.)/(PRF-1.)
      ETAFCF=ETAFDS/ETAF
      WAFCF=WAFDS/WAF
      WRITE(6,100)PRFCF,ETAFCF,WAFCF,T2DS
100   FORMAT(11H0FAN DESIGN,13X8H  PRFCF=,E15.8,8H ETAFCF=,E15.8,
     18H  WAFCF=,E15.8,8H   T2DS=,E15.8)
1     PRF=PRFCF*(PRF-1.)+1.
      ETAF=ETAFCF*ETAF
      WAF=WAFCF*WAF
      CALL THCOMP(PRF,ETAF,T2,H2,S2,P2,T21,H21,S21,P21)
      IF(PCBLF.GT.0.) BLF=PCBLF*WAF
      IF(JDES.EQ.1) GO TO 7
      JDES=1
      IF(INIT.EQ.1) GO TO 6
      IF(IDES.EQ.1) GO TO 4
      IF(MODE.NE.2) GO TO 2
      T4=GUESS(3,Y1,Y2,PCNF,PCNFDS,WF8,WF8DS,Y7,Y8,T4DS)
      PCNI=GUESS(8,T4,T4DS,Y3,Y4,Y5,Y6,T21,T21DS,PCNIDS)
      PCNC=GUESS(4,Y1,Y2,PCNF,PCNFDS,WF8,WF8DS,Y7,Y8,PCNCDS)
      GO TO 5
2     IF(MODE.EQ.1) GO TO 3
      IF(MODE.EQ.0) GO TO 20
      T4=GUESS(7,Y1,Y2,PCNF,PCNFDS,Y5,Y6,T2,T2DS,T4DS)
20    PCNC=GUESS(5,T4,T4DS,Y3,Y4,Y5,Y6,T21,T21DS,PCNCDS)
      PCNI=GUESS(9,Y1,Y2,PCNC,PCNCDS,Y5,Y6,T21,T21DS,PCNIDS)
      GO TO 5
3     T4=GUESS(6,Y1,Y2,PCNC,PCNCDS,Y5,Y6,T21,T21DS,T4DS)
      PCNI=GUESS(8,T4,T4DS,Y3,Y4,Y5,Y6,T21,T21DS,PCNIDS)
      GO TO 5
4     PCNC=PCNCDS
      PCNI=PCNIDS
      T4=T4DS
      WF8=WF8DS
      T21DS=T21
5     ZC=ZCDS
      ZI=ZIDS
      PCNIGU=PCNI
      PCNCGU=PCNC
      T4GU=T4
6     INIT=0
7     IF(MODE.NE.3) GO TO 8
      IF(ABS(CNF-CNFS).LE.0.001*CNFS) GO TO 9
      WRITE(6,2000)CNFS,CNF
2000  FORMAT(10H0CNF WAS= ,E15.8,11H  AND NOW= ,E15.8,
     124H  CHECK PCNF INPUT$$$$$$)
      CALL ERROR
 8    PCNF=100.*THETA*CNF/THETAD
9     CALL COINTC
      RETURN
      END
      SUBROUTINE COINTC
      COMMON/    ALL/
     1WORD   ,IDES   ,JDES   ,KDES   ,MODE   ,INIT   ,IDUMP  ,IANTP  ,
     2IGASMX,IDBURN,IAFTBN,IDCD   ,IMCD   ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCCU ,T4GU    ,DLMD1   ,DELFG   ,DELFN   ,DELSFC  ,
     2ZFDS    ,PCNFDS ,PRFDS  ,ETAFDS  ,WAFDS   ,PRFCF   ,ETAFCF  ,WAFCF   ,
     3ZIDS    ,PCNIDS ,PRIDS  ,ETAIDS  ,WAIDS   ,PRICF   ,ETAICF  ,WAICF   ,
     4ZCDS    ,PCNCDS ,PRCDS  ,ETACDS  ,WACDS   ,PRCCF   ,ETACCF  ,WACCF   ,
     5T4DS    ,WFBDS  ,DTCODS ,ETABDS  ,WA3CDS  ,DPCODS  ,DTCOCF  ,ETABCF  ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF  ,CNHPCF  ,ETHPCF  ,DHHPCF  ,T2DS    ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF  ,CNIPCF  ,ETIPCF  ,DHIPCF  ,T21DS   ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF  ,CNLPCF  ,ETLPCF  ,DHLPCF  ,T22DS   ,
     9T24DS   ,WFDDS  ,DTDUDS ,ETADDS  ,WA23DS  ,DPDUDS  ,DTDUCF  ,ETADCF  ,
     AT7DS    ,WFADS  ,DTAFDS ,ETAADS  ,WG6CDS  ,DPAFDS  ,DTAFCF  ,ETAACF  ,
     BA55     ,A25    ,A6     ,A7      ,A8      ,A9      ,A28     ,A29
     CPS55    ,AM55   ,CVDNOZ ,CVMNOZ  ,A8SAV   ,A9SAV   ,A28SAV  ,A29SAV
      COMMON/ FRCNT/
     1T1      ,P1     ,H1     ,S1      ,T2      ,P2      ,H2      ,S2      ,
     2T21     ,P21    ,H21    ,S21     ,T22     ,P22     ,H22     ,S22     ,
     3T3      ,P3     ,H3     ,S3      ,T4      ,P4      ,H4      ,S4      ,
     4T45     ,P45    ,H45    ,S45     ,T5      ,P5      ,H5      ,S5      ,
     5T55     ,P55    ,H55    ,S55     ,BLF     ,BLI     ,BLC     ,BLDU    ,
     6CNF     ,PRF    ,ETAF   ,WAFC    ,WAF     ,BLDUI   ,BLDUC   ,BLOB    ,
     7CNI     ,PRI    ,ETAI   ,WAIC    ,WAI     ,BLOBI   ,BLOBC   ,WA3     ,
     8CNC     ,PRC    ,ETAC   ,WACC    ,WAC     ,ETAB    ,DPCCM   ,WG4     ,
     9CNHP    ,ETATHP ,DHTCHP ,DHTC    ,BLHP    ,BLHPI   ,BLHPC   ,FAR4    ,
     ACNIP    ,ETATIP ,DHTCIP ,DHTI    ,BLIP    ,BLIPI   ,BLIPC   ,DUMF    ,
     BCNLP    ,ETATLP ,DHTCLP ,DHTF    ,BLLP    ,BLLPI   ,BLLPC   ,CS      ,
     CWG45    ,FAR45  ,WG5    ,FAR5    ,WG55    ,FAR55   ,HPEXT   ,AM
     DALTP    ,ETAR   ,ZF     ,PCNF    ,ZI      ,PCNI    ,ZC      ,PCNC
     EWFB     ,TFFHP  ,TFFIP  ,TFFLP   ,PCBLF   ,PCBLI   ,PCBLC   ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/IPHP/WA22
      COMMON/   INT/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),
     1NCN,NPT(15)
      DIMENSION WLH(2)
      DATA AWORD,WLH/6HCOINTC,6H (LO) ,6H (HI) /
      WORD=AWORD
      THETA=SQRT(T21/518.668)
      IF(IDES.NE.1) GO TO 10
      THETAD=THETA
   10 CNI=PCNI*THETAD/(100.*THETA)
      IF(ZI.LT.0.) ZI=0.
      IF(ZI.GT.1.) ZI=1.
      CNIS=CNI
      CALL SEARCH(ZI,CNI,PRI,WAIC,ETAI,
     1CNX(1),NCN,PRX(1,1),WACX(1,1),ETAX(1,1),NPT(1),15,15,IGO)
      IF((CNI-CNIS).GT..0005*CNI) MAPEDG=1
      IF(IGO.EQ.1.OR.IGO.EQ.2) WRITE(8,1000) CNIS,WLH(IGO)
 1000 FORMAT(19H0* * *  CNI OFF MAP,F10.4,2XA6,11H* * *$$$$$$)
      WAI=WAIC*P21/THETA
      IF(IDES.NE.1) GO TO
      PRICF=(PRIDS-1.)/(PRI-1.)
      ETAICF=ETAIDS/ETAI
      WAICF=WAIDS/WAI
      WRITE(6,100)PRICF,ETAICF,WAICF,T21DS
100   FORMAT (23H0I.P. COMPRESSOR DESIGN,1X8H  PRICF=,E15.8,8H ETAICF
     1E15.8,8H  WAICF=,E15.8,8H  T21DS=,E15.8)
1     PRI=PRICF*(PRI-1.)+1.
      ETAI=ETAICF*ETAI
      WAI=WAICF*WAI
      CALL THCOMP(PRI,ETAI,T21,H21,S21,P21,T22,H22,S22,P22)
      IF(IDES.EQ.1) T22DS=T22
      IF(PCBLI.GT.0) BLI=PCBLI*WAI
      WA22=WAI-BLI
      BLDUI=PCBLCUI*BLI
      BLHPI=PCBLHPI*BLI
      BLIPI=PCBLIPI*BLI
      BLOBI=PCBLCBI*BLI
      PCNI=100.*THETA*CNI/THETAD
      CALL COCOMP
      RETURN
      END
      SUBROUTINE COCOMP
      COMMON /    ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCO  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWF8    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDU ,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/IPHP/WA22
      COMMON / COMP/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),
     1NCN,NPT(15)
      DIMENSION WLH(2)
      DATA AWORD,WLH/6HCOCOMP,6H (LO) ,6H (HI) /
      WORD=AWORD
      THETA=SQRT(T22/518.688)
      IF(IDES.NE.1) GO TO 10
      THETAD=THETA
 10   CNC=PCNC*THETAD/(100.*THETA)
      IF(ZC.LT.0.) ZC=0.
      IF(ZC.GT.1.) ZC=1.
      CNCS=CNC
      CALL SEARCH(ZC,CNC,PRC,WACC,ETAC,
     1CNX(1),NCN,PRX(1,1),WACX(1,1),ETAX(1,1),NPT(1),15,15,IGO)
      IF(MODE.EQ.1) GO TO 1
      IF((CNC-CNCS).GT.0.0005*CNC) MAPEDG=1
 1    IF(IGO.EQ.1.OR.IGO.EQ.2) WRITE(8,1000) CNCS,WLH(IGO)
 1000 FORMAT(19H0* * *  CNC OFF MAP,F10.4,2XA6,11H* * *$$$$$$)
      WAC=WACC*P22/THETA
      IF(IDES.NE.1) GC TO 2
      WACDS=WA22
      PRCCF=(PRCDS-1.)/(PRC-1.)
      ETACCF=ETACDS/ETAC
      WACCF=WACDS/WAC
      WRITE(6,100)PRCCF,ETACCF,WACCF,T22DS
  100 FORMAT(23H0H.P. COMPRESSOR DESIGN,1X8H  PRCCF=,E15.8,8H ETACCF=,
     1E15.8,8H  WACCF=,E15.8,8H  T22DS=,E15.8)
 2    PRC=PRCCF*(PRC-1.)+1.
      ETAC=ETACCF*ETAC
      WAC=WACCF*WAC
      CALL THCOMP(PRC,ETAC,T22,H22,S22,P22,T3,H3,S3,P3)
      IF(PCBLC.GT.0.) BLC=PCBLC*WAC
      WA3=WAC-BLC
      BLDUC=PCBLCUC*BLC
      BLHPC=PCBLHPC*BLC
      BLIPC=PCBLIPC*BLC
      BLLPC=PCBLLPC*BLC
      BLOBC=PCBLOBC*BLC
      BLDU=BLDUI+BLDUC
      BLHP=BLHPI+BLHPC
      BLIP=BLIPI+BLIPC
      BLLP=BLLPI+BLLPC
      BLOB=BLOBI+BLCBC
      IF(MODE.NE.1) GO TO 3
      IF(ABS(CNC-CNCS).LE.0.001*CNCS) GO TO 4
      WRITE(6,2000)CNCS,CNC
 2000 FORMAT(10H0CNC WAS= ,E15.8,11H  AND NOW= ,E15.8,
     124H  CHECK PCNC INPUT$$$$$)
      CALL ERROR
  3   PCNC=100.*THETA*CNC/THETAD
   4  ERR(7)=(WAC-WA22)/WAC
      CALL COCOMB
      RETURN
      END
```

```
       SUBROUTINE CCCOMB
       COMMON /   ALL/
      1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
      2IGASMX,ICBURN,IAFTBN,IDCD  ,IMCC  ,IDSHOC,IMSHOC,NOZFLT,
      3ITRYS,LCOPER,NOMAF,NUMMAP,MAPEDG,TOLALL,ERR(9)
       COMMON/DESIGN/
      1PCNFGU ,PCNIGU ,FCNCGU ,T4GU   ,DLMD1  ,DELFG  ,DELFN  ,DELSFC ,
      2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
      3ZIDS   ,PCNICS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
      4ZCDS   ,PCNCCS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
      5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
      6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T20S   ,
      7TFIPDS ,CNIPCS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
      8TFLPDS ,CNLPCS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
      9T240S  ,WFDDS  ,CTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
      AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
      BA55    .A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
      CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
       COMMON/ FRCNT/
      1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
      2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
      3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
      4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
      5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
      6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
      7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
      8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
      9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
      ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
      BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
      CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
      DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
      EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
      FPCBLDUC,PCBLCBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
      GPCBLLPC
       COMMON / COMB/PSI(15),DELT(15,15),ETA(15,15),NPS,NPT(15)
       CIMENSION G(9),CUMBO(15,15)
       DATA AWORD/6HCOCOMB/
       WORD=AWORD
       Q(2)=0.
       Q(3)=0.
       P3PSI=14.696*P3
       WA3C=WA3*SGRT(T3)/P3PSI
       IF(IDES.EQ.1) WA3CDS=WA3C
       DPCOM=DPCOCS*(WA3C/WA3CDS)
       IF(DPCOM.GT.1.) DPCOM=1.
       P4=P3*(1.-DPCOM)
1      IF(T4.GT.3999.) T4=3999.
       IF(T4.GE.1000.) GO TO 2
       T4=1000.
       IF(MOCE.EQ.1) MAPEDG=1
2      CTCO=T4-T3
       IF(IDES.NE.1) GC TO 3
       DTCOCF=DTCCDS/DTCO
3      CTCO=CTCOCF*CTCC
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```
      F3PSIN=P3PSI
      CALL SEARCH(-1.,P3PSIN,DTCO,ETAB,CUMMY,
     1PSI(1),NPS,DELT(1,1),ETA(1,1),DUMEO(1,1),NPT(1),15,15,IGO)
      IF(IGO.EQ.7) CALL ERROR
4     IF(IDES.NE.1) GO TO 5
      ETABCF=ETABDS/ETAB
5     ETAB=ETABCF*ETAB
      HV=((((((-.4594317E-19*T4)-.2034116E-15)*T4+.2783643E-11)*T4
     1+.2051501E-07)*T4-.2453116E-03)*T4-.9433296E-01)*T4+.1845537E+05
      CALL THERMO(P4,HA,T4,XX1,XX2,0,0.0,0)
      FAR4=(HA-H3)/(HV*ETAB)
      IF(FAR4.LT.0.) FAR4=0.
      WFBX=FAR4*WA3
      IF(MODE.NE.2) GO TO 8
      ERRW=(WFB-WFBX)/WFB
      DIR=SQRT(WFB/WFBX)
      CALL AFQUIR(Q(1),T4,ERRW,0.,20.,0.0001,DIR,T4T,IGO)
      GO TO (6,9,7),IGO
6     T4=T4T
      GO TO 1
7     CALL ERROR
8     WFB=WFBX
9     CALL THERMO(F4,H4,T4,S4,XX2,1,FAR4,0)
      WG4=WFB+WA3
      IF(IDES.EQ.1) WRITE(6,100) WA3CDS,ETABCF,DTCOCF
100   FORMAT(17H0COMBUSTOR DESIGN,7X8H WA3CDS=,E15.8,8H ETABCF=,E15.8,
     18H DTCOCF=,E15.8)
      CALL COMPTB
      RETURN
      END
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```
       SUBROUTINE COMPTB
       COMMON /    ALL/
      1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
      2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
      3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
       COMMON/DESIGN/
      1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
      2ZFDS   ,PCNFCS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
      3ZIDS   ,PCNICS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
      4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
      5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
      6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
      7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
      8TFLPDS ,CNLPCS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLFCF ,T22DS  ,
      9T24DS  ,WFCDS  ,CTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
      AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
      BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
      CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
       COMMON/ FRONT/
      1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
      2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
      3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
      4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
      5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
      6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
      7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
      8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
      9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
      ACNIP   ,ETATIF ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
      BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
      CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
      DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
      EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
      FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHFI,PCBLHPC,PCBLIFI,PCBLIPC,PCBLLPI,
      GPCBLLFC
       COMMON /HTLRB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),
      1NTFFS,NPTTFF(15)
       DATA AWORD,WLO,WHI/6HCOMPTB,6H (LO) ,6H (HI) /
       WORD=AWORD
       IF(IDES.EQ.0) GO TO 1
       CNHPCF=CNHPDS*SQRT(T4)/PCNC
 1     CNHP=CNHPCF*PCNC/SQRT(T4)
       CNHPS=CNHP
       TFFHPS=TFFHP
       CALL SEARCH(-1.,TFFHP,CNHP,DHTCHP,ETATHP,
      1TFFX(1),NTFFS,CNX(1,1),DHTCX(1,1),ETATX(1,1),NPTTFF(1),15,15,I
       IF(IGO.EQ. 1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE(8,1000)TFFHPS,WL
       IF(IGO.EQ. 2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE(8,1000)TFFHPS,WHI
       IF(IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE(8,2000) CNHPS,WLO
       IF(IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE(8,2000) CNHPS,WHI
 1000  FORMAT(19H0*****TFFHP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
 2000  FORMAT(19H0***** CNHP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
       IF(IGO.NE.7) GO TO 3
 2     CALL ERROR
       RETURN
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3     MAPGO=0
      IF(ABS(TFFHPS-TFFHP).LE.0.001*TFFHPS) GO TO 4
      MAPGO=1
      IF(ABS(CNHPS-CNHP).GT.0.001*CNHPS) MAPGO=3
      GO TO 5
4     IF(ABS(CNHPS-CNHP).GT.0.001*CNHPS) MAPGO=2
5     IF(MAPGO.GT.0) CALL MAPBAC(1,MAPGO,TFFHPS,TFFHP,CNHPS,CNHP,PCNC,
     1T4,MODE,NOMAP,NUMMAP)
      IF(NOMAP.GT.0) RETURN
      TFHCAL=WG4*SQRT(T4)/(14.696*P4)
      BTUEXT=0.706705*HPEXT
      DHTCC=(BTUEXT+WAC*(H3-H22))/(WG4*T4)
      IF(IDES.EQ.0) GO TO 6
      TFHPCF=TFHPDS/TFHCAL
      DHHPCF=DHTCC/DHTCHP
      ETHPCF=ETHPDS/ETATHP
      WRITE(6,102)CNHPCF,TFHPCF,ETHPCF,CHHPCF
102   FORMAT(20H0H.P. TURBINE DESIGN,5X7HCNHPCF=,E15.8,8H TFHPCF=,E15.8,
     18H ETHPCF=,E15.8,8H DHHPCF=,E15.8)
6     TFHCAL=TFHPCF*TFHCAL
      DHTCHP=DHHPCF*DHTCHP
      ETATHP=ETHPCF*ETATHP
      DHTC=DHTCC*T4
      ERR(1)=(TFHCAL-TFFHP)/TFHCAL
      ERR(2)=(DHTCC-DHTCHP)/DHTCC
      CALL THTURB(CHTC,ETATHP,FAR4,H4,S4,P4,T45,H45,S45,P45)
      IF(BLHP.LE.0.) GO TO 7
      FAR45=WFB/(WA3+BLHP)
      WG45=WG4+BLHP
      H45=(BLHPI*H22+BLHPC*H3+WG4*H45)/WG45
      CALL THERMC(P45,H45,T45,S45,XX2,1,FAR45,1)
      GO TO 8
 7    FAR45=FAR4
      WG45=WG4
 8    CALL COIPTB
      RETURN
      END
      SUBROUTINE CCIPTB
      COMMON/   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOCPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRCNT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/ITURB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),
     1NTFFS,NPTTFF(15)
      DATA AWORD,WLO,WHI/6HCOIPTB,6H (LO) ,6H (HI) /
      WORD=AWORD
      IF(IDES.EQ.0) GO TO 1
      CNIPCF=CNIPDS*SQRT(T45)/PCNI
 1    CNIP=CNIPCF*PCNI/SQRT(T45)
      CNIPS=CNIP
      TFFIPS=TFFIP
      CALL SEARCH(-1.,TFFIP,CNIP,DHTCIP,ETATIP,
     1TFFX(1),NTFFS,CNX(1,1),DHTCX(1,1),ETATX(1,1),NPTTFF(1),15,15,IGO
      IF(IGO.EQ. 1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE(8,1000)TFFIPS,WLO
      IF(IGO.EQ. 2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE(8,1000)TFFIPS,WHI
      IF(IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE(8,2000) CNIPS,WLO
      IF(IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE(8,2000) CNIPS,WHI
1000 FORMAT(19H0*****TFFIP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
2000 FORMAT(19H0***** CNIP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
      IF(IGO.NE.7) GO TO 3
2     CALL ERROR
      RETURN
```

```
3     MAPGO=0
      IF(ABS(TFFIPS-TFFIP).LE.0.001*TFFIPS) GO TO 4
      MAPGO=1
      IF(ABS(CNIPS-CNIP).GT.0.001*CNIPS) MAPGO=3
      GO TO 5
4     IF(ABS(CNIPS-CNIP).GT.0.001*CNIPS) MAPGO=2
5     IF(MAPGO.GT.0) CALL MAPBAC(3,MAPGO,TFFIPS,TFFIP,CNIPS,CNIP,PCNI,
     1T4,MODE,NOMAP,NUMMAP)
      IF(NOMAP.GT.0) RETURN
      TFICAL=WG45*SQRT(T45)/(14.696*P45)
      DHTIC=(WAI*(H22-H21))/(WG45*T45)
      IF(IDES.EQ.0) GO TO 6
      TFIPCF=TFIPDS/TFICAL
      DHIPCF=DHTIC/DHTCIP
      ETIPCF=ETIPDS/ETATIP
      WRITE(6,102)CNIPCF,TFIPCF,ETIPCF,DHIPCF
102   FORMAT(20HOI.P. TURBINE DESIGN,5X7HCNIPCF=,E15.8,8H TFIPCF=,E15.
     18H ETIPCF=,E15.8,8H DHIPCF=,E15.8)
6     TFICAL=TFIPCF*TFICAL
      DHTCIP=DHIPCF*DHTCIP
      ETATIP=ETIPCF*ETATIP
      DHTI=DHTIC*T45
      ERR(8)=(TFICAL-TFFIP)/TFICAL
      ERR(9)=(DHTIC-DHTCIP)/DHTIC
      CALL THTURB (DHTI,ETATIP,FAR45,H45,S45,P45,T5,H5,S5,P5)
      IF(BLIP.LE.0) GO TO 7
      FAR5=WFB/(WA3+BLHP+BLIP)
      WG5=WG45+BLIP
      H5=(BLIPI*H22+BLIPC*H3+WG45*H5)/WG5
      CALL THERMO(P5,H5,T5,S5,XX2,1,FAR5,1)
      GO TO 8
7     FAR5=FAR45
      WG5=WG45
8     CALL COLPT8
      RETURN
      END
      SUBROUTINE CCLPTB
      COMMON /   ALL/
     1WORD   ,IDES   ,JDES   ,KDES   ,MODE   ,INIT   ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD   ,IMCD   ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU    ,DLMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON /LTURB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),
     1NTFFS,NPTTFF(15)
      DATA AWORD,WLO,WHI/6HCOLPTB,6H (LO) ,6H (HI) /
      WORD=AWORD
      IF(IDES.EQ.0) GO TO 1
      CNLPCF=CNLPDS*SQRT(T5)/PCNF
1     CNLP=CNLPCF*PCNF/SQRT(T5)
      CNLPS=CNLP
      TFFLPS=TFFLP
      CALL SEARCH(-1.,TFFLP,CNLP,DHTCLP,ETATLP,
     1TFFX(1),NTFFS,CNX(1,1),DHTCX(1,1),ETATX(1.1),NPTTFF(1),15,15,IGO)
      IF(IGO.EQ. 1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE(8,1000)TFFLPS,WLO
      IF(IGO.EQ. 2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE(8,1000)TFFLPS,WHI
      IF(IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE(8,2000) CNLPS,WLO
      IF(IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE(8,2000) CNLPS,WHI
1000  FORMAT(19H0*****TFFLP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
2000  FORMAT(19H0***** CNLP OFF MAP,F10.4,2XA6,11H*****$$$$$$)
      IF(IGO.NE.7) GO TO 3
2     CALL ERROR
      RETURN
```

```
3       MAPGO=0
        IF(ABS(TFFLPS-TFFLP).LE.0.001*TFFLPS) GO TO 4
        MAPGO=1
        IF(ABS(CNLPS-CNLP).GT.0.001*CNLPS) MAPGO=3
        GO TO 5
4       IF(ABS(CNLPS-CNLP).GT.0.001*CNLPS) MAPGO=2
5       IF(MAPGO.GT.0) CALL MAPBAC(2,MAPGO,TFFLPS,TFFLP,CNLPS,CNLP,PCNF,
       1T4,MODE,NOMAP,NUMMAP)
        IF(NOMAP.GT.0) RETURN
        TFLCAL=WG5*SQRT(T5)/(14.696*P5)
        DHTCF=WAF*(H21-H2)/(WG5*T5)
        IF(IDES.EQ.0) GO TO 6
        TFLPCF=TFLPDS/TFLCAL
        DHLPCF=DHTCF/DHTCLP
        ETLPCF=ETLPDS/ETATLP
        WRITE(6,102)CNLPCF,TFLPCF,ETLPCF,DHLPCF
102     FORMAT(20H0L.P. TURBINE DESIGN,5X7HCNLPCF=,E15.8,8H TFLPCF=,E15.8
       18H ETLPCF=,E15.8,8H DHLPCF=,E15.8)
6       TFLCAL=TFLPCF*TFLCAL
        DHTCLP=DHLPCF*DHTCLP
        ETATLP=ETLPCF*ETATLP
        DHTF=DHTCF*T5
        ERR(3)=(TFLCAL-TFFLP)/TFLCAL
        ERR(4)=(DHTCF-DHTCLP)/DHTCF
        CALL THTURB(DHTF,ETATLP,FAR5,H5,S5,P5,T55,H55,S55,P55)
        IF(BLLP.LE.0.) GO TO 7
        FAR55=WF8/(WA3+BLHP+BLIP+BLLP)
        WG55=WG5+BLLP
        H55=(BLLPI*H22+BLLPC*H3+WG5*H55)/WG55
        CALL THERMO(P55,H55,T55,S55,XX2,1,FAR55,1)
           GO TO 8
7       FAR55=FAR5
        WG55=WG5
8       CALL FRTOSO
        RETURN
        END
```

```
      SUBROUTINE FRTOSD
      COMMON/ FRONT/
     1T1      ,P1      ,H1      ,S1      ,T2      ,P2      ,H2      ,S2      ,
     2T21     ,P21     ,H21     ,S21     ,T22     ,P22     ,H22     ,S22     ,
     3T3      ,P3      ,H3      ,S3      ,T4      ,P4      ,H4      ,S4      ,
     4T45     ,P45     ,H45     ,S45     ,T5      ,P5      ,H5      ,S5      ,
     5T55     ,P55     ,H55     ,S55     ,BLF     ,BLI     ,BLC     ,BLOU    ,
     6CNF     ,PRF     ,ETAF    ,WAFC    ,WAF     ,BLOUI   ,BLOUC   ,BLOB    ,
     7CNI     ,PRI     ,ETAI    ,WAIC    ,WAI     ,BLOBI   ,BLOBC   ,WA3     ,
     8CNC     ,PRC     ,ETAC    ,WACC    ,WAC     ,ETAB    ,DPCOM   ,WG4     ,
     9CNHP    ,ETATHP  ,DHTCHP  ,DHTC    ,BLHP    ,BLHPI   ,BLHPC   ,FAR4    ,
     ACNIP    ,ETATIP  ,DHTCIP  ,DHTI    ,BLIP    ,BLIPI   ,BLIPC   ,DUMF    ,
     BCNLP    ,ETATLP  ,DHTCLP  ,DHTF    ,BLLP    ,BLLPI   ,BLLPC   ,CS      ,
     CWG45    ,FAR45   ,WG5     ,FAR5    ,WG55    ,FAR55   ,HPEXT   ,AM      ,
     DDLTF    ,ETAR    ,ZF      ,PCNF    ,ZI      ,PCNI    ,ZC      ,PCNC    ,
     EWFB     ,TFFHP   ,TFFIP   ,TFFLP   ,PCBLF   ,PCBLI   ,PCBLC   ,PCBLOUI,
     FPCBLOUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1     ,XWAF    ,XWAI    ,XWAC    ,XBLF    ,XBLOU   ,XBLOUI  ,XBLOUC  ,
     2XH22    ,XH3     ,XT21    ,XP21    ,XH21    ,XS21    ,DUMS1   ,DUMS2   ,
     3T23     ,P23     ,H23     ,S23     ,T24     ,P24     ,H24     ,S24     ,
     4T25     ,P25     ,H25     ,S25     ,T28     ,P28     ,H28     ,S28     ,
     5T29     ,P29     ,H29     ,S29     ,DUMS3   ,DUMS4   ,DUMS5   ,DUMS6   ,
     6WAD     ,WFL     ,WG24    ,FAR24   ,ETAD    ,DPDUC   ,BYPASS  ,DUMS7   ,
     7TS28    ,PS28    ,V28     ,AM28    ,TS29    ,PS29    ,V29     ,AM29
      XP1=P1
      XWAF=WAF
      XWAI=WAI
      XWAC=WAC
      XBLF=BLF
      XBLOU=BLOU
      XBLOUI=BLOUI
      XBLOUC=BLOUC
      XH22=H22
      XH3=H3
      XT21=T21
      XP21=P21
      XH21=H21
      XS21=S21
      CALL CODUCT
      RETURN
      END
      SUBROUTINE CODUCT
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IOCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T20S   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T210S  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T220S  ,
     9T240S  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/  SIDE/
     1 P1    , WAF   , WAI   , WAC   , ELF   , BLDU  , BLDUI , BLDUC ,
     2 H22   , H3    , T21   , P21   , H21   , S21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
     6WAD    ,WFC    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      DIMENSION Q(9)
      DATA AWORD1,AWORD2/6HCODUCT,6HNOZZL/
      WORD=AWORD1
      Q(2)=0.
      Q(3)=0.
      WAX=WAF-WAI-ELF
      WAD=WAX+BLDU
      P23=P21
      H23=(BLDUI*H22+BLDUC*H3+WAX*H21)/WAD
      CALL THERMC(P23,H23,T23,S23,XX2,1,0.0,1)
      BYPASS=(WAF-WAI)/WAI
      WA23C=WAD*SQRT(T23)/P23
      IF(IDES.EQ.1) WA23DS=WA23C
      DPDUC=DPDUDS*(WA23C/WA23DS)
      IF(DPDUC.GT.1.) DPDUC=1.
      P24=P23*(1.-DPDUC)
      IF(IGASMX.GT.0) IDBURN=0
      IF(IDBURN.NE.0) GO TO 2
      T24=T23
      WFD=0.
      FAR24=0.
      GO TO 7
2     IF(IDBURN.EQ.2) T24=T23+2000.
3     IF(T24.GT.4000.) T24=4000.
      IF(T24.LT.T23) T24=T23
C *** IF DESIRED, ENTER CALCULATIONS FOR ETAD HERE
      HV=((((((-.4594317E-19*T24)-.2034116E-15)*T24+.2783643E-11)*T24+
     1.2051501E-07)*T24-.2453116E-03)*T24-.9433296E-01)*T24+.1845537E+
      CALL THERMC(P24,HA,T24,XX1,XX2,0,0.0,0)
      FAR24=(HA-H23)/(HV*ETAD)
      IF(FAR24.LT.0.) FAR24=0.
      WFOX=FAR24*WAD
      IF(IDBURN.NE.2) GO TO 6
      ERRW=(WFD-WFOX)/WFD
      DIR=SQRT(WFD/WFOX)
      CALL AFQUIR(Q(1),T24,ERRW,0.,20.,0.0001,DIR,T24T,IGO)
      GO TO (4,7,5),IGO
4     T24=T24T
      GO TO 3
5     CALL ERROR
6     WFD=WFOX
7     CALL THERMO(P24,H24,T24,S24,XX2,1,FAR24,0)
      WG24=WFD+WAD
      IF(IDES.EQ.1) WRITE(6,101) WA23DS
101   FORMAT(12HODUCT DESIGN,12X8H WA23DS=,E15.8)
C *** IF DESIRED, ENTER OTHER LOSSES HERE
      T25=T24
      P25=P24
      H25=H24
      S25=S24
      IF(IGASMX.GT.0) GO TO 11
      WORD=AWORD2
      A28SAV=A28
      A29SAV=A29
      NOZD=0
      IDNOZ=0
      IF(NOZFLT.EQ.2.OR.NOZFLT.EQ.3) NOZD=1
      IF(IDES.EQ.1.OR.IDBURN.GT.0.OR.NOZD.EQ.1) IDNOZ=1
      IF(IOCD.EQ.1) GO TO 8
      CALL CONVRG(T25,H25,P25,S25,FAR24,WG24,P1,IDNOZ,A28,     P25R,
     1T28,H28,P28,S28,TS28,PS28,V28,AM28,ICON)
      GO TO (9,9,3,5),ICON
8     CALL CONDIV(T25,H25,P25,S25,FAR24,WG24,P1,IDNOZ,A28,A29,P25R,
     1T28,H28,P28,S28,T29,H29,P29,S29,TS28,TS29,PS28,PS29,V28,V29,A
     2AM29,ICON)
      IDSHOC=ICON
      GO TO (10,10,10,5),ICON
9     T29=T28
      H29=H28
      P29=P28
      S29=S28
      TS29=TS28
      PS29=PS28
      V29=V28
      AM29=AM28
      A29=A28
      IDSHOC=ICON+3
10    ERR(5)=(P25R-P25)/P25R
      IF(IDNOZ.EQ.1) WRITE(6,100) A28,AM28,A29,AM29
100   FORMAT(19HODUCT NOZZLE DESIGN,5X8H     A28=,E15.8,8H    AM28=,E1
     18H     A29=,E15.8,8H    AM29=,E15.8)
11    CALL FASTBK
      RETURN
      END
      SUBROUTINE FASTBK
      COMMON/ FRCNT/
     1T1      ,P1      ,H1      ,S1      ,T2      ,P2      ,H2      ,S2      ,
     2T21     ,P21     ,H21     ,S21     ,T22     ,P22     ,H22     ,S22     ,
     3T3      ,P3      ,H3      ,S3      ,T4      ,P4      ,H4      ,S4      ,
     4T45     ,P45     ,H45     ,S45     ,T5      ,P5      ,H5      ,S5      ,
     5T55     ,P55     ,H55     ,S55     ,BLF     ,BLI     ,BLC     ,BLDU    ,
     6CNF     ,PRF     ,ETAF    ,WAFC    ,WAF     ,BLDUI   ,BLDUC   ,BLOB    ,
     7CNI     ,PRI     ,ETAI    ,WAIC    ,WAI     ,BLOBI   ,BLOBC   ,WA3     ,
     8CNC     ,PRC     ,ETAC    ,WACC    ,WAC     ,ETAB    ,DPCOM   ,WG4     ,
     9CNHP    ,ETATHP  ,DHTCHP  ,DHTC    ,BLHP    ,BLHPI   ,BLHPC   ,FAR4    ,
     ACNIP    ,ETATIP  ,DHTCIP  ,DHTI    ,BLIP    ,BLIPI   ,BLIPC   ,DUMF    ,
     BCNLP    ,ETATLP  ,DHTCLP  ,DHTF    ,BLLP    ,BLLPI   ,BLLPC   ,CS      ,
     CWG45    ,FAR45   ,WG5     ,FAR5    ,WG55    ,FAR55   ,WPEXT   ,AM      ,
     DALTP    ,ETAR    ,ZF      ,PCNF    ,ZI      ,PCNI    ,ZC      ,PCNC    ,
     EWFB     ,TFFHP   ,TFFIP   ,TFFLP   ,PCBLF   ,PCBLI   ,PCBLC   ,PCBLDUI,
     FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1     ,XWAF    ,XWAI    ,XWAC    ,XBLF    ,XBLDU   ,XBLDUI  ,XBLDUC  ,
     2XH22    ,XH3     ,XT21    ,XP21    ,XH21    ,XS21    ,DUMS1   ,DUMS2   ,
     3T23     ,P23     ,H23     ,S23     ,T24     ,P24     ,H24     ,S24     ,
     4T25     ,P25     ,H25     ,S25     ,T28     ,P28     ,H28     ,S28     ,
     5T29     ,P29     ,H29     ,S29     ,DUMS3   ,DUMS4   ,DUMS5   ,DUMS6   ,
     6WAD     ,WFD     ,WG24    ,FAR24   ,ETAD    ,DPDUC   ,BYPASS  ,DUMS7   ,
     7TS28    ,PS28    ,V28     ,AM28    ,TS29    ,PS29    ,V29     ,AM29
      COMMON /  EACK/
     XXT55    ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,
     XXWFB    ,XWG55  ,XFAR55,XWFD    ,XWG24  ,XFAR24,XXP1    ,DUMB   ,
     3T6      ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,
     4T8      ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,
     5WG6     ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,
     6PS6     ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,
     7TS8     ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,
     8VA      ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,
     9FGM     ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC
      XT55=T55
      XP55=P55
      XH55=H55
      XS55=S55
      XT25=T25
      XP25=P25
      XH25=H25
      XS25=S25
      XWFB=WFB
      XWG55=WG55
      XFAR55=FAR55
      XWFD=WFD
      XWG24=WG24
      XFAR24=FAR24
      XXP1=P1
      CALL COMIX
      RETURN
      END
      SUBROUTINE COMIX
      DIMENSION QQ(9)
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T20S   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/FRONT/DUMF1(98),ZF,PCNF,DUMF2(21)
      COMMON /  BACK/
     1T55   ,P55   ,H55   ,S55   ,T25   ,P25   ,H25   ,S25   ,
     2WFB   ,WG55  ,FAR55 ,WFD   ,WG24  ,FAR24 ,P1    ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      DATA AWORD/6H COMIX/
      WORD=AWORD
      AJ=778.26
      CAPSF=2116.2170
      G=32.174049
      CALL PROCOM(FAR55,T55,XX1,XX2,XX3,XX4,PHI55,XX5)
      CALL PROCOM(FAR24,T25,XX1,XX2,XX3,XX4,PHI25,XX5)
      IF(IDES.EQ.0) GO TO 6
C *** CALCULATE A55 AND A25 WITH PS25=PS55
      IF(PS55.EQ.0.) GO TO 50
      TS55=T55*(PS55/P55)**0.286
      DO 1 I=1,15
      CALL PROCOM(FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)
      PHIS=PHI55-REX55*ALOG(P55/PS55)
      DELPHI=PHIS-PHIS55
      IF(ABS(DELPHI).LE.0.0001*PHIS) GO TO 3
1     TS55=TS55*EXP(4.0*DELPHI)
2     CALL ERROR
      RETURN
50    TS55=0.875*T55
      DO 51 I=1,15
      CALL PROCOM(FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)
      V55=AM55*CS55
      HSCAL=H55-V55**2/(2.*G*AJ)
      DELHS=HSCAL-HS55
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 52
51    TS55=TS55+DELHS/CP55
      GO TO 2
52    PS55=P55/EXP((PHI55-PHIS55)/REX55)
 3    IF(H55.GT.HS55) GO TO 53
      WRITE(6,101)P55,PS55,T55,TS55,H55,HS55
101   FORMAT(22H0SQRT OF H55-HS55 NEG ,6E15.6,6H$$$$$$)
      CALL ERROR
53    V55=SQRT(2.*G*AJ*(H55-HS55))
      RHO=CAPSF*PS55/(AJ*REX55*TS55)
      A55=WG55/(RHO*V55)
      AM55=V55/CS55
      IF(IGASMX.GT.0) GO TO 54
      WRITE(6,104)A55,AM55
104   FORMAT(20H0TURBINE AREA DESIGN,6X6H  A55=,E15.8,8H   AM55=,E15.8
      GO TO 34
54    PS25=PS55
      TS25=T25*(PS25/P25)**0.286
      DO 4 I=1,15
      CALL FROCOM(FAR24,TS25,CS25,AK25,CP25,REX25,PHIS25,HS25)
      PHIS=PHI25-REX25*ALOG(P25/PS25)
      DELPHI=PHIS-PHIS25
      IF(ABS(DELPHI).LE.0.0001*PHIS) GO TO 5
4     TS25=TS25*EXP(4.0*DELPHI)
      GO TO 2
5     IF(H25.GT.HS25) GO TO 55
      WRITE(6,102)P25,PS25,T25,TS25,H25,HS25
102   FORMAT(22H0SQRT OF H25-HS25 NEG ,6E15.6,6H$$$$$$)
      CALL ERROR
55    V25=SQRT(2.*G*AJ*(H25-HS25))
      RHO=CAPSF*PS25/(AJ*REX25*TS25)
      A25=WG24/(RHO*V25)
      AM25=V25/CS25
      WRITE(6,100)A55,AM55,A25,AM25
100   FORMAT(25H0TURBINE/DUCT AREA DESIGN,7H   A55=,E15.8,
     18H   AM55=,E15.8,8H   A25=,E15.8,8H   AM25=,E15.8)
      GO TO 20
C *** CALCULATE PS55 AND PS25
6     WQA=WG55/A55
      C1=P55*SQRT(G/(T55*AJ))*CAPSF
      MCON=0
      QQ(2)=0.
      QQ(3)=0.
      AM55=0.50
      TS55=0.875*T55
7     DO 8 I=1,15
      CALL FROCOM(FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)
      V55=AM55*CS55
      HSCAL=H55-V55**2/(2.*G*AJ)
      DELHS=HSCAL-HS55
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 9
8     TS55=TS55+DELHS/CP55
      GO TO 2
9     WQAT=C1*SQRT(AK55/REX55)*AM55/(1.+(AK55-1.)*AM55**2/2.)**
     1((AK55+1.)/(2.*(AK55-1.)))
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      AMX=AM55
      IGOGO=0
10    DIR=WQA/WQAT
      EW=(WQA-WQAT)/WQA
      CALL AFQUIR(QQ(1),AMX,EW,0.,30.,0.0005,DIR,AMXT,ICON)
      GO TO (11,15,2),ICON
11    IF(AMXT.LE.1.0) GO TO 13
      AMXT=0.7
      MCON=MCON+1
      IF(MCON.LE.1) GO TO 13
      IF(MOCE.EQ.3) GO TO 120
      WRITE(8,103)FCNF,AMX,F55,PS55,P25,PS25
103   FORMAT(12H0COMIX PCNF=,F7.4,4H AM=,F8.6,5H P55=,F9.5,
     16H PS55=,F9.5,5H P25=,F9.5,6H PS25=,F9.5,6H$$$$$$)
      PCNF=1.01*PCNF
12    NOMAP=7
      RETURN
120   WRITE(8,121)ZF,AMX,P55,PS55,P25,PS25
121   FORMAT(10H0CCMIX ZF=,F8.5,4H AM=,F8.6,5H P55=,F9.5,
     16H PS55=,F9.5,5H P25=,F9.5,6H PS25=,F9.5,6H$$$$$$)
      ZF=0.99*ZF
      GO TO 12
13    IF(IGOGO.EC.1) GO TO 14
      AM55=AMXT
      GO TO 7
14    AM25=AMXT
      GO TO 16
15    IF(IGOGO.EQ.1) GO TO 19
      PS55=P55/EXP((PHI55-PHIS55)/REX55)
      IF(IGASMX.LE.0) GO TO 34
      WQA=WG24/A25
      C1=P25*SQRT(G/(T25*AJ))*CAPSF
      MCON=0
      QQ(2)=0.
      QQ(3)=0.
      AM25=0.25
      TS25=0.875*T25
16    DO 17 I=1,15
      CALL PROCOM(FAR24,TS25,CS25,AK25,CP25,REX25,PHIS25,HS25)
      V25=AM25*CS25
      HSCAL=H25-V25**2/(2.*G*AJ)
      DELHS=HSCAL-HS25
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 18
17    TS25=TS25+DELHS/CP25
      GO TO 2
18    WQAT=C1*SQRT(AK25/REX25)*AM25/(1.+(AK25-1.)*AM25**2/2.)**
     1((AK25+1.)/(2.*(AK25-1.)))
      AMX=AM25
      IGOGO=1
      GO TO 10
19    PS25=P25/EXP((PHI25-PHIS25)/REX25)
20    WG6=WG24+WG55
      ERR(5)=(PS25-PS55)/PS25
      WF6=WFD+WFB
      FAR6=WF6/(WG6-WF6)
      H6=(WG24*H25+WG55*H55)/WG6
      CALL THERMO(1.,H6,T6,PHI6,AMX,1,FAR6,1)
      C1=PS55*A55*(1.+AK55*AM55**2)+PS25*A25*(1.+AK25*AM25**
      TS6=0.833*T6
      DO 25 I=1,15
      CALL PROCOM(FAR6,TS6,CS6,AK6.CP6,REX6,PHIS6,HS6)
      C2=WG6*SQRT(AJ*REX6*T6/(AK6*G))
      C3=C2/(CAPSF*C1)
      C4=(AK6-1.)/2.-(C3*AK6)**2
      C5=1.-2.*AK6*C3**2
      C6=C5**2+4.*C4*C3**2
      IF(C6)21,22,23
21    CALL ERROR
      RETURN
22    AM62G=-C5/(2.*C4)
      GO TO 24
23    AM62G=(SQRT(C6)-C5)/(2.*C4)
24    IF(AM62G.LE.0.) GO TO 21
      AM6G=SQRT(AM62G)
      V6=AM6G*CS6
      HSCAL=H6-V6**2/(2.*G*AJ)
      DELHS=HSCAL-HS6
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 26
25    TS6=TS6+DELHS/CP6
      GO TO 21
26    IF(IGASMX.GT.0) A6G=A25+A55
      C7=SQRT(1.+(AK6-1.)*AM62G/2.)
      PS6=C2/(CAPSF*A6G*AM6G*C7)
      P6=PS6*EXP((PHI6-PHIS6)/REX6)
      CALL THERMO(P6,H6,T6,S6,XX1,1,FAR6,0)
      S6AVE=(WG24*S25+WG55*S55)/WG6
      IF(S6.GE.S6AVE) GO TO 27
      S6=S6AVE
      P6=EXP(AMX*(PHI6-S6)/1.986375)
27    IF(IGASNX.EQ.1) GO TO 35
      IF(IDES.EQ.0) GO TO 30
C *** CALCULATE  A6 AS A FUNCTION OF INPUT AM6
      TS6=T6/(1.0+(((AK6-1.0)/2.0)*AM6**2.))
      DO 28 JJ=1,15
      CALL PROCOM(FAR6,TS6,CS6,AK6,CP6,REX6,PHIS6,HS6)
      V6=AM6*CS6
      HSCAL=H6-V6**2./(2.*G*AJ)
      DELHS=HSCAL-HS6
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 2
28    TS6=TS6+DELHS/CP
      GO TO 28
29    PS6=P6/((1.0+(((AK6-1.0)/2.0)*AM6**2.))**(AK6/(AK6-1.0)))
      AM6DS=AM6
      RHO=CAPSF*PS6/(AJ*REX6*TS6)
      A6=WG6/(RHO*V6)
      WRITE(6,200) A6
200   FORMAT(1H0,    35HAFTERBURNER ENTRANCE DESIGN AREA A6  ,F8.3)
      GO TO 36
C *** CALCULATES AM6=F(A6DESIGN)
30    TS6P=T6/(1.0+(((AK6-1.0)/2.0)*AM6DS**2.))
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      DO 32 I=1,15
      CALL PROCOM (FAR6,TS6P,CS6,AK6,CP6,REX6,PHIS6,HS6)
      PS6P=PS6*(TS6P/TS6)**(AK6/(AK6-1.0))
      RHO=CAPSF*FS6P/(AJ*REX6*TS6P)
      IF(H6.GT.HS6) GO TO 31
      WRITE(8,201)P6,PS6P,T6,TS6P
201   FORMAT(20H0SQRT OF H6-HS6 NEG ,6E15.6,6H$$$$$$)
      CALL ERROR
31    V6=SQRT(2.*G*AJ*(H6-HS6))
      A6P=WG6/(RHO*V6)
      DELA6=A6P-A6
      V6=WG6/(RHO*A6)
      AM6=V6/CS6
      AM62=AM6**2.
      IF(ABS(DELA6).LE.0.002*A6)  GO TO 33
32    TS6P=T6/(1.0+(((AK6-1.0)/2.0)*AM62))
      GO TO 21
33    TS6=TS6P
      PS6=PS6P
      GO TO 36
34    T6=T55
      P6=P55
      H6=H55
      S6=S55
      WG6=WG55
      PS6=PS55
      V6=V55
      AM6=AM55
      IF(IGASMX.EQ.0) A6=A55
      GO TO 36
35    AM62=AM62G
      AM6=AM6G
      A6=A25+A55
36    CALL COAFBN
      RETURN
      END
      SUBROUTINE COAFBN
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,ICBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF
     3ZIDS   ,PCNICS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS
     7TFIPDS ,CNIPCS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF
     8A55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON /  BACK/
     1T55    ,P55    ,H55    ,S55    ,T25    ,P25    ,H25    ,S25    ,
     2WFB    ,WG55   ,FAR55  ,WFD    ,WG24   ,FAR24  ,P1     ,DUMB   ,
     3T6     ,P6     ,H6      S6     ,T7     ,P7     ,H7     ,S7     ,
     4T8     ,P8     ,H8      S8     ,T9     ,P9     ,H9     ,S9     ,
     5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,
     6FS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,
     7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,
     8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,
     9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC
      DIMENSION C(9)
      DATA AWORD/6HCOAFBN/
      WORD=AWORD
      C(2)=0.
      Q(3)=0.
      AJ=778.26
      CAPSF=2116.2170
      G=32.174049
      WF6=WFB
      IF(IGASMX.GT.0) WF6=WF6+WFD
      WA6=WG6-WF6
C *** DRY LOSS
      WG6C=WG6*SQRT(T6)/P6
2     IF(IDES.EQ.1) WG6CDS=WG6C
      DPAFT=DPAFDS*(WG6C/WG6CDS)
      IF(DPAFT.GT.1.) DPAFT=1.
      P7=P6*(1.-DPAFT)
      A7=A6
      FAR6=WF6/WA6
      CALL FROCOM(FAR6,T6,XX1,XX2,XX3,XX4,PHI6,XX6)
      WQA=WG6/A7
      C1=P7*SQRT(G/(T6*AJ))*CAPSF
      AM7=AM6
      TS7=0.875*T6
20    DO 22 I=1,15
      CALL FROCOM(FAR6,TS7,CS7,AK7,CP7,REX7,PHIS7,HS7)
      V7=AM7*CS7
      HSCAL=H6-V7**2/(2.*G*AJ)
      DELHS=HSCAL-HS7
      IF(ABS(DELHS).LE.0.0005*HSCAL) GO TO 24
22    TS7=TS7+DELHS/CP7
      GO TO 8
24    WQAT=C1*SQRT(AK7/REX7)*AM7/(1.+(AK7-1.)*AM7**2/2.)**
     1((AK7+1.)/(2.*(AK7-1.)))
      DIR=WQA/WQAT
      EW=(WQA-WQAT)/WQA
      CALL AFQUIR(Q(1),AM7,EW,0.,30.,0.0005,DIR,AM7T,IGO)
      GO TO (26,28,8),IGO
26    AM7=AM7T
      IF(AM7.GE.1.0) AM7=0.9
      GO TO 20
28    PS7=P7/EXP((PHI6-PHIS7)/REX7)
      IF(IAFTBN.GT.0) GO TO 4
C *** NON-AFTERBURNING
3     T7=T6
      WFA=0.0
      FAR7=FAR6
      WG7=WG6
      GO TO 13
C *** AFTERBURNING
4     IF(IAFTBN.EQ.2) T7=T6+2000.
      IF(T7.LE.T6) GO TO 3
      RHO65=CAPSF*PS7/(AJ*REX7*TS7)
      PS65=PS7
      V65=V7
      Q(2)=0.
      Q(3)=0.
5     IF(T7.GT.4000.) T7=4000.
C *** IF DESIRED, ENTER CALCULATIONS FOR ETAA HERE
      HV=((((((-.4594317E-19*T7)-.2034116E-15)*T7+.2783643E-11)*T7
     1+.2051501E-07)*T7-.2453116E-03)*T7-.9433296E-01)*T7+.1845537E+05
      CALL THERMO(F7,HA,T7,XX1,XX2,0,0.0,0)
      FAR7=(HA-H6)/(HV*ETAA)
      IF(FAR7.GT.0.) GO TO 6
      T7=T6
      GO TO 5
6     WFAX=FAR7*WG6
      IF(IAFTBN.EQ.1) GO TO 9
      ERRW=(WFA-WFAX)/WFA
      DIR=SQRT(WFA/WFAX)
      CALL AFQUIR(Q(1),T7,ERRW,0.,20.,0.0001,DIR,T7T,IGO)
      GO TO (7,10,8),IGO
7     T7=T7T
      GO TO 5
8     CALL ERROR
9     WFA=WFAX
10    FAR7=(WF6+WFA)/WA6
      WG7=WG6+WFA
C *** MOMENTUM LOSS
      CALL PROCOM(FAR7,T7,XX1,XX2,XX3,REX7,PHI7,H7)
      RHO7=CAPSF*P7/(AJ*REX7*T7)
      V7=WG7/(RHO7*A7)
      Q(2)=0.
      Q(3)=0.
      FS7=PS65-0.01
11    RHO7=WG7/(V7*A7)
      HS7=H7-V7**2/(2.*G*AJ)
      CALL THERMO(1.0,HS7,TS7,PHIS7,XX2,1,FAR7,1)
      IF(TS7.GE.301.) GO TO 110
      CALL THERMC(1.0,HS7,400.,PHIS7,XX2,1,FAR7,0)
      V7=SQRT(2.*G*AJ*(H7-HS7))
      GO TO 11
110   PS7=RHO7*AJ*REX7*TS7/CAPSF
      PS7A=PS65+(RHO65*V65**2-RHO7*V7**2)/(C[illegible]PSF)
      DIR=SQRT(ABS(PS7/PS7A))
      EP=(PS7-PS7A)/PS7
      CALL AFQUIR(Q(1),V7,EP,0.,50.,0.0005,DIR,V7T,IGO)
      V7=V7T
      IF(V7.LT.100.) V7=100.
      GO TO (11,12,8),IGO
12    P7=PS7*EXP((PHI7-PHIS7)/REX7)
      CALL FROCOM(FAR7,TS7,CS7,XX2,XX3,XX4,XX5,XX6)
      AM7=V7/CS7
13    CALL THERMO(P7,H7,T7,S7,XX2,1,FAR7,0)
      IF(IDES.EQ.1) WRITE(6,100) WG6COS
100   FORMAT(19H0AFTERBURNER DESIGN,5X8H WG6COS=,E15.8)
      CALL COMNOZ
      RETURN
      END
      SUBROUTINE COMNOZ
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DLM01  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON /   EACK/
     1T55   ,P55   ,H55   ,S55   ,T25   ,P25   ,H25   ,S25   ,
     2WFB   ,WG55  ,FAR55 ,WFD   ,WG24  ,FAR24 ,P1    ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      DATA AWORD/6HMNOZZL/
      WORD=AWORD
      A8SAV=A8
      A9SAV=A9
      NOZM=0
      IMNOZ=0
      IF(NOZFLT.EQ.1.OR.NOZFLT.EQ.3) NOZM=1
      IF(IDES.EQ.1.OR.IAFTBN.GT.0.OR.NOZM.EQ.1) IMNOZ=1
      IF(IMCD.EQ.1) GO TO 1
      CALL CONVRG(T7,H7,P7,S7,FAR7,WG7,F1,IMNOZ,A8,    P7R,
     1T8,H8,P8,S8,TS8,PS8,V8,AM8,ICON)
      GO TO (3,3,3,2),ICON
1     CALL CONDIV(T7,H7,P7,S7,FAR7,WG7,F1,IMNOZ,A8,A9,P7R,
     1T8,H8,P8,S8,T9,H9,P9,S9,TS8,TS9,PS8,PS9,V8,V9,AM8,AM9,ICON)
      IMSHOC=ICON
      GO TO (4,4,4,2),ICON
2     CALL ERROR
3     T9=T8
      H9=H8
      P9=P8
      S9=S8
      TS9=TS8
      PS9=PS8
      V9=V8
      AM9=AM8
      A9=A8
      IMSHOC=ICON+3
```

```
4      ERR(6)=(P7R-F7)/P7R
       IF(INNOZ.EQ.1) WRITE(6,100) A8,AM8,A9,AM9
100    FORMAT(14H0NOZZLE DESIGN,10X8H      A8=,E15.8,8H     AM8=,E15.8,
     18H      A9=,E15.8,8H     AM9=,E15.8)
       RETURN
       END
```

```
      SUBROUTINE PERF
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DLMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCCM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWF8    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLCBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC ,
     2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
     6WAD    ,WFC    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      COMMON /  BACK/
     XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
     XXWF8  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      DATA AWORD/6H  PERF/
      WORD=AWORD
      G=32.174049
      CAPSF=2116.2170
      WFT=WFB+WFD+WFA
      WAT=WAF-BLOB
      WGT=WAT+WFT
      FART=WFT/WAT
      VA=AM*CS
      FRD=VA*WAF/G
      VJM=CVMNOZ*V9
      FGMM=VJM*WG7/G
      FGPM=CAPSF*(PS9-P1)*A9
      IF(IGASMX.GT.0) GO TO 1
      VJD=CVDNOZ*V29
      FGMD=VJD*WG24/G
      FGPD=CAPSF*(PS29-P1)*A29
1     FGM=FGMM+FGMD
      FGP=FGPM+FGPD
      FG=FGM+FGP
      FN=FG-FRD
      SFC=3600.*WFT/FN
      FG=DELFG*FG
      FN=DELFN*FN
      SFC=DELSFC*SFC
      CALL CUTPUT
      CALL ERROR
      RETURN
      END
      SUBROUTINE CCNOUT(ICON)
      DIMENSION WORDY(345),IOUT(150),AOUT(6),WOUT(6),PARAM1(96),
     1 PARAM2(121),PARAM3(56),PARAM4(72)
      COMMON /   ALL/
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,
     2IGASMX,IDBURN,IAFTBN,IDCO  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEOG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  .
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  .
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BLI    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLC
     FPCBLDUC,PCBLCBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLP,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC
     2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    .
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6
     6WFD    ,WFC    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      COMMON /  BACK/
     XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
     XXWF8  ,XHG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUM8  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
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```
 EQUIVALENCE (PARAM1(1),PCNFGU),(PARAM2(1),T1),(PARAM3(1),XP1),
1 (PARAM4(1),XT55)
 DATA (WORDY(I),I=1,96)/
17HPCNFGU ,7HPCNIGU ,7HPCNCGU ,7HT4GU   ,7HDUMD1  ,7HDELFG  ,
27HDELFN  ,7HDELSFC ,7HZFDS   ,7HPCNFDS ,7HPRFDS  ,7HETAFDS ,
37HWAFDS  ,7HPRFCF  ,7HETAFCF ,7HWAFCF  ,7HZIDS   ,7HPCNIDS ,
47HPRIDS  ,7HETAIDS ,7HWAIDS  ,7HPRICF  ,7HETAICF ,7HWAICF  ,
57HZCDS   ,7HPCNCDS ,7HPRCDS  ,7HETACDS ,7HWACDS  ,7HPRCCF  ,
67HETACCF ,7HWACCF  ,7HT4DS   ,7HWFBDS  ,7HDTCCDS ,7HETABDS ,
77HWA3CDS ,7HDPCODS ,7HDTCOCF ,7HETABCF ,7HTFHPDS ,7HCNHPDS ,
87HETHFDS ,7HTFHPCF ,7HCNHPCF ,7HETHPCF ,7HDHHPCF ,7HT2DS   ,
97HTFIPDS ,7HCNIPDS ,7HETIPDS ,7HTFIPCF ,7HCNIPCF ,7HETIPCF ,
17HDHIPCF ,7HT21DS  ,7HTFLPDS ,7HCNLPDS ,7HETLPDS ,7HTFLPCF ,
27HCNLPCF ,7HETLPCF ,7HDHLPCF ,7HT22DS  ,7HT24DS  ,7HWFDDS  ,
37HDTOUDS ,7HETADDS ,7HWA23DS ,7HDPOUDS ,7HDTDUCF ,7HETADCF ,
47HT7DS   ,7HWFADS  ,7HDTAFDS ,7HETAADS ,7HWG6CDS ,7HDPAFDS ,
57HDTAFCF ,7HETAACF ,7HA55    ,7HA25    ,7HA6     ,7HA7     ,
67HA8     ,7HA9     ,7HA28    ,7HA29    ,7HPS55   ,7HAM55   ,
77HCVDNOZ ,7HCVMNOZ ,7HA8SAV  ,7HA9SAV  ,7HA28SAV ,7HA29SAV /
 DATA (WORDY(I),I=97,150)/
17HT1     ,7HP1     ,7HH1     ,7HS1     ,7HT2     ,7HP2     ,
27HH2     ,7HS2     ,7HT21    ,7HP21    ,7HH21    ,7HS21    ,
37HT22    ,7HP22    ,7HH22    ,7HS22    ,7HT3     ,7HP3     ,
47HH3     ,7HS3     ,7HT4     ,7HP4     ,7HH4     ,7HS4     ,
57HT45    ,7HP45    ,7HH45    ,7HS45    ,7HT5     ,7HP5     ,
67HH5     ,7HS5     ,7HT55    ,7HP55    ,7HH55    ,7HS55    ,
77HBLF    ,7HBLI    ,7HBLC    ,7HBLDU   ,7HCNF    ,7HPRF    ,
87HETAF   ,7HWAFC   ,7HWAF    ,7HBLDUI  ,7HBLDUC  ,7HBLOB   ,
97HCNI    ,7HPRI    ,7HETAI   ,7HWAIC   ,7HWAI    ,7HBLOBI  /
 DATA (WORDY(I),I=151,217)/
17HBLOBC  ,7HWA3    ,7HCNC    ,7HPRC    ,7HETAC   ,7HWACC   ,
27HWAC    ,7HETAB   ,7HDPCOM  ,7HWG4    ,7HCNHP   ,7HETATHP ,
37HDHTCHP ,7HCHTC   ,7HBLHP   ,7HBLHPI  ,7HBLHPC  ,7HFAR4   ,
47HCNIP   ,7HETATIP ,7HDHTCIP ,7HDHTI   ,7HBLIP   ,7HBLIPI  ,
57HBLIPC  ,7HCUMF   ,7HCNLP   ,7HETATLP ,7HDHTCLP ,7HDHTF   ,
67HBLLP   ,7HBLLPI  ,7HBLLPC  ,7HCS     ,7HWG45   ,7HFAR45  ,
77HWG5    ,7HFAR5   ,7HWG55   ,7HFAR55  ,7HHPEXT  ,7HAM     ,
87HALTP   ,7HETAR   ,7HZF     ,7HPCNF   ,7HZI     ,7HPCNI   ,
97HZC     ,7HPCNC   ,7HWFB    ,7HTFFHP  ,7HTFFIP  ,7HTFFLP  ,
17HPCBLF  ,7HPCBLI  ,7HPCBLC  ,7HPCBLDUI,7HPCBLDUC,7HPCBLOBI,
27HPCBLOBC,7HPCBLHPI,7HPCBLHPC,7HPCBLIPI,7HPCBLIPC,7HPCBLLPI,
37HPCBLLPC/
 DATA (WORDY(I),I=218,273)/
17HXP1    ,7HXWAF   ,7HXHA1   ,7HXWAC   ,7HXBLF   ,7HXBLDU  ,
27HXBLDUI ,7HXBLDUC ,7HXH22   ,7HXH3    ,7HXT21   ,7HXP21   ,
37HXH21   ,7HXS21   ,7HDUMS1  ,7HDUMS2  ,7HT23    ,7HP23    ,
47HH23    ,7HS23    ,7HT24    ,7HP24    ,7HH24    ,7HS24    ,
57HT25    ,7HP25    ,7HH25    ,7HS25    ,7HT28    ,7HP28    ,
67HH28    ,7HS28    ,7HT29    ,7HP29    ,7HH29    ,7HS29    ,
77HDUMS3  ,7HDUMS4  ,7HDUMS5  ,7HDUMS6  ,7HWAD    ,7HWFD    ,
87HWG24   ,7HFAR24  ,7HETAD   ,7HDPDUC  ,7HBYPASS ,7HDUMS7  ,
97HTS28   ,7HPS28   ,7HV28    ,7HAM28   ,7HTS29   ,7HPS29   ,
17HV29    ,7HAM29   /
 DATA (WORDY(I),I=274,345)/
17HXT55   ,7HXP55   ,7HXH55   ,7HXS55   ,7HXT25   ,7HXP25   ,
     27HXH25   ,7HXS25   ,7HXWF8   ,7HXWG55  ,7HXFAR55 ,7HXWFD    ,
     37HXWG24  ,7HXFAR24 ,7HXXP1   ,7HDLMB   ,7HT6     ,7HP6      ,
     47HH6     ,7HS6     ,7HT7     ,7HP7     ,7HH7     ,7HS7      ,
     57HT8     ,7HP8     ,7HH8     ,7HS8     ,7HT9     ,7HP9      ,
     67HH9     ,7HS9     ,7HWG6    ,7HWFA    ,7HWG7    ,7HFAR7    ,
     77HETAA   ,7HCPAFT  ,7HV55    ,7HV25    ,7HPS6    ,7HV6      ,
     87HAM6    ,7HTS7    ,7HPS7    ,7HV7     ,7HAM7    ,7HAM25    ,
     97HTS8    ,7HPS8    ,7HV8     ,7HAM8    ,7HTS9    ,7HPS9     ,
     17HV9     ,7HAM9    ,7HVA     ,7HFRD    ,7HVJD    ,7HFGMD    ,
     27HVJM    ,7HFGMM   ,7HFGPD   ,7HFGPM   ,7HFGM    ,7HFGP     ,
     37HWFT    ,7HWGT    ,7HFART   ,7HFG     ,7HFN     ,7HSFC     /
      DATA THEEND,BLANK,LIMIT/7HTHEEND ,7H       ,345/
      GO TO (1,12),ICON
C *** INPUT SECTION
 1    DO 4 N=1,150
      NUM=N
      READ(5,100)AIN,CHANGE
      IF(AIN.EQ.THEEND ) GO TO 5
      DO 2 J=1,LIMIT
      JJ=J
      IF(AIN.EQ.WORDY(J)) GO TO 3
2     CONTINUE
      WRITE(6,101)AIN
      GO TO 4
3     IOUT(NUM)=JJ
      IF(CHANGE.NE.BLANK) WORDY(JJ)=CHANGE
4     CONTINUE
      WRITE(6,102)
5     NUM=NUM-1
      RETURN
C *** OUTPUT SECTICN
12    IF(NUM.EQ.1) GO TO 16
      N=NUM
      J=6
      DO 15 I=1,NUM,6
      IF(N.GT.6) GC TO 13
      J=N
 13   N=N-6
      DO 14 K=1,J
      L=I+K-1
      M=IOUT(L)
      WOUT(K)=WORDY(M)
      IF(M.GT.96) GO TO 20
      AOUT(K)=PARAM1(M)
      GO TO 14
  20  IF(M.GT.217) GO TO 21
      MN=M-96
      AOUT(K)=PARAM2(MN)
      GO TO 14
  21  IF(M.GT.273) GO TO 22
      MN=M-217
      AOUT(K)=PARAM3(MN)
      GO TO 14
  22  MN=M-273
      AOUT(K)=PARAM4(MN)
```

```
   14 CONTINUE
      WRITE(6,103) (WOUT(K),K=1,J)
      WRITE(6,104) (AOUT(K),K=1,J)
      IF(N.LE.0) GC TO 16
15    CONTINUE
16    RETURN
 100  FORMAT(A7,7X,A7)
 101  FORMAT('.0H0THE WCRD ,A7,26H NOT FCUND IN COMMON ARRAY)
 102  FORMAT(22H0ERROR IN CONOUT INPUT)
 103  FORMAT(1H ,25XA7,5(8XA7))
104   FORMAT(1H ,20X6E15.6)
      END
 SUBROUTINE ERROR
 DIMENSION TRASH1(96),TRASH2(121),TRASH3(56),TRASH4(72)
 COMMON /   ALL/
1WORD   ,IDES   ,JDES   ,KDES   ,MODE   ,INIT   ,IDUMP ,IAMTP ,
2IGASMX,IDBURN,IAFTBN,IDCD   ,IMCD   ,IDSHOC,IMSHOC,NOZFLT,
3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
 COMMON/DESIGN/
1PCNFGU ,PCNIGU ,PCNCGU ,T4GU    ,DUMD1   ,DELFG   ,DELFN   ,DELSFC  ,
2ZFDS    ,PCNFDS ,PRFDS   ,ETAFDS ,WAFDS   ,PRFCF   ,ETAFCF ,WAFCF   ,
3ZIDS    ,PCNIDS ,PRIDS   ,ETAIDS ,WAIDS   ,PRICF   ,ETAICF ,WAICF   ,
4ZCDS    ,PCNCDS ,PRCDS   ,ETACDS ,WACDS   ,PRCCF   ,ETACCF ,WACCF   ,
5T4DS    ,WFBDS   ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCCCF ,ETABCF ,
6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS    ,
7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS   ,
8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS   ,
9T24DS   ,WFDDS   ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
AT7DS    ,WFADS   ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
BA55     ,A25     ,A6      ,A7      ,A8      ,A9      ,A28     ,A29     ,
CPS55    ,AM55    ,CVDNOZ ,CVMNOZ ,A8SAV   ,A9SAV   ,A28SAV ,A29SAV
 COMMON/ FRONT/
1T1      ,P1      ,H1      ,S1      ,T2      ,P2      ,H2      ,S2      ,
2T21     ,P21     ,H21     ,S21     ,T22     ,P22     ,H22     ,S22     ,
3T3      ,P3      ,H3      ,S3      ,T4      ,P4      ,H4      ,S4      ,
4T45     ,P45     ,H45     ,S45     ,T5      ,P5      ,H5      ,S5      ,
5T55     ,P55     ,H55     ,S55     ,BLF     ,BLI     ,BLC     ,BLDU    ,
6CNF     ,PRF     ,ETAF    ,WAFC    ,WAF     ,BLDUI   ,BLDUC   ,BLOB    ,
7CNI     ,PRI     ,ETAI    ,WAIC    ,WAI     ,BLOBI   ,BLOBC   ,WA3     ,
8CNC     ,PRC     ,ETAC    ,WACC    ,WAC     ,ETAB    ,DPCOM   ,WG4     ,
9CNHP    ,ETATHP ,DHTCHP ,DHTC    ,BLHP    ,BLHPI   ,BLHPC   ,FAR4    ,
ACNIP    ,ETATIP ,DHTCIP ,DHTI    ,BLIP    ,BLIPI   ,BLIPC   ,DUMF    ,
BCNLP    ,ETATLP ,DHTCLP ,DHTF    ,BLLP    ,BLLPI   ,BLLPC   ,CS      ,
CWG45    ,FAR45   ,WG5     ,FAR5    ,WG55    ,FAR55   ,HPEXT   ,AM      ,
DALTP    ,ETAR    ,ZF      ,PCNF    ,ZI      ,PCNI    ,ZC      ,PCNC    ,
EWFB     ,TFFHP   ,TFFIP   ,TFFLP   ,PCBLF   ,PCBLI   ,PCBLC   ,PCBLDUI,
FPCBLDUC,PCBLOBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
GPCBLLPC
 COMMON/  SIDE/
1XP1     ,XWAF    ,XWAI    ,XWAC    ,XBLF    ,XBLDU   ,XBLDUI ,XBLDUC ,
2X[illegible]   ,XH3     ,XT21    ,XP21    ,XH21    ,XS21    ,DUMS1   ,DUMS2   ,
3T23     ,P23     ,H23     ,S23     ,T24     ,P24     ,H24     ,S24     ,
4T25     ,P25     ,H25     ,S25     ,T28     ,P28     ,H28     ,S28     ,
5T29     ,P29     ,H29     ,S29     ,DUMS3   ,DUMS4   ,DUMS5   ,DUMS6   ,
6W[illegible]    ,WFC     ,WG24    ,FAR24   ,ETAD    ,DPDUC   ,BYPASS ,DUMS7   ,
7TS28    ,PS28    ,V28     ,AM28    ,TS29    ,PS29    ,V29     ,AM29
 COMMON /  BACK/
XXT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,
XXW[illegible]  ,XWG55  ,XFAR55,XWFD   ,XWG24  ,XFAR24,XXP1   ,DUMB   ,
3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,
4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,
5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,
6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,
7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,
8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,
9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC
 EQUIVALENCE(TRASH1(1),PCNFGU),(TRASH2(1),T1),(TRASH3(1),XP1)
```

```
      EQUIVALENCE (TRASH4(1),XT55)
      DATA AWORD/6HCOMMON/
      WRITE(6,100)WORD
      WORD=AWORD
      WRITE(6,102)WORD,ZF,PCNF,ZI,PCNI,ZC,PCNC,T4,MODE
      WRITE(6,103)
      WRITE(6,104)(TRASH1(I),I=1,96)
      WRITE(6,105)
      WRITE(6,104)(TRASH2(I),I=1,121)
      WRITE(6,105)
      WRITE(6,104)(TRASH3(I),I=1,56)
      WRITE(6,103)
      WRITE(6,104)(TRASH4(I),I=1,72)
      WRITE(6,103)
      WRITE(6,106)LOOPER
      IF(IDUMP.EQ.0) GO TO 2
      WRITE(6,105)
      CALL SYG(2)
2     CALL ENGBAL
      RETURN
100   FORMAT(28H0AN ERROR HAS BEEN FOUND IN ,A6)
 102  FORMAT(1H0,A6,9X,7E15.6,I4)
103   FORMAT(2H0 )
104   FORMAT(1H0,8E15.6)
105   FORMAT(1H1)
106   FORMAT(25H0FAILED TO CONVERGE AFTER,I4,6H LOOPS)
      END
      SUBROUTINE SYG(ICON)
      DIMENSION WORD(132)
      DATA ONEDOL/6H$     /
      GO TO (1,2),ICON
1     END FILE 8
      REWIND 8
      RETURN

C        TERMINATE THE FILE

2     WRITE(8,500)
500   FORMAT(12H$$$$$$$$$$$$)
      END FILE 8
      REWIND 8

C        READ RECORD

5     READ(8,501)(WORD(I),I=1,132)
501   FORMAT(132A1)

C        CHECK FOR 12 LEADING DOLLAR SIGNS

      DO 10 I=1,12
      IF(WORD(I)-ONEDOL)11,10,11
10    CONTINUE
      RETURN

C        CHECK FOR 6 TRAILING DOLLAR SIGNS
11    DO 15 I=1,132

      IF(WORD(I)-ONEDOL)15,12,15
12    K=I+5
      DO 13 J=I,K
      IF(WORD(J)-ONEDOL)15,13,15
13    CONTINUE
      GO TO 20
15    CONTINUE
      WRITE(6,502)
502   FORMAT(1H0,12HERROR IN SYG)
      RETURN

         PRINT LINE

 0    I=I-1
      WRITE(6,505)(WORD(M),M=1,I)
 505  FORMAT(132A1)
      GO TO 5
      END
      SUBROUTINE THCOMP(PR,ETA,T,H,S,P,TO,HO,SO,PO)
      PO=P*FR
      TP=T*PR**0.28572
      DO 1 I=1.25
      CALL THERMC(FO,HP,TP,SP,X1,0,X2,0)
      DELS=SP-S
      IF(ABS(DELS).LE.0.00005*S) GO TO 2
1     TP=TP/EXP(4.*DELS)
      CALL ERROR
2     HO=H+((HF-H)/ETA)
      CALL THERMC(FO,HC,TO,SO,X1,0,X2,1)
      RETURN
      END
      SUBROUTINE THTURB(DH,ETA,FAR,H,S,P,TO,HO,SO,PO)
      HO=H-DH
      HOP=H-DH/ETA
      PT=P/2.
      DO 1 I=1,25
      CALL THERMC(PT,HOP,TT,ST,AMWT,1,FAR,1)
      DELS=ST-S
      IF(ABS(DELS).LE.0.00005*S) GO TO 2
1     PT=P*EXP(DELS*AMWT/1.986375+ALOG(PT/P))
      CALL ERROR
2     PO=PT
      CALL THERMC(PO,HO,TO,SO,X1,1,FAR,1)
      RETURN
      END
      SUBROUTINE PROCOM(FARX,TEX,CSEX,AKEX,CPEX,REX,PHI,HEX)
      IF(FARX.LE.0.067623) GO TO 1
      FARX=0 067623
      WRITE(8,101)
1     IF(TEX.GE.300.) GO TO 2
      TEX=300.
      WRITE(8,102)
2     IF(TEX.LE.4000.) GO TO 3
      TEX=4000.
      WRITE(8,103)
3     IF(FARX.GE.0,0) GO TO 4
      FARX=0.0
      WRITE(8,104)
C     AIR PATH
4     CPA =(((((1.0115540E-25*TEX-1.4526770E-21)*TEX
     1+7.62157 7E-18)*TEX-1.5122259E-14)*TEX-6.7178376E-12)
     2*TEX+6.5519486E-08)*TEX-5.1536879E-05)*TEX+2.5020051E-01
      HEA=((((((1.2644425E-26*TEX-2.1752522E-22)*TEX
     1+1.2702630E-18)*TFX-3,0256518E-15)*TEX-1.6794594E-12)*TEX
     2+2.1839826E-08)*TEX-2.5743440E-05)*TEX+2.5020051E-01)*TEX
     3-1.755883E+00
      SEA=+2.5020051E-01*ALOG(TEX)+((((((1.4450767E-26*TEX
     1-2.4211288E-22)*TEX+1.5243153E-18)*TEX-3.7820648E-15)*TEX
     2-2.2392790E-12)*TEX+3.2759743E-08)*TEX-5.1576879E-05)*TEX
     3+4.5432300E-02
      IF(FARX.LE.0.0) GO TO 5
C     FUEL/AIR PATH
      CPF =(((((7.2678710E-25*TEX-1.3335668E-20)*TEX
     1+1.0212913E-16)*TEX-4.2051104E-13)*TEX+3.9686793E-10)*TEX
     2-1.3771901E-06)*TEX+1.2258630E-03)*TEX+7.3816638E-02
      HEF=((((((9.0848338E-26*TEX-1.9050949E-21)*TEX
     1+1.7021525E-17)*TEX-8.4102208E-14)*TEX+2.4921698E-10)*TEX
     2-4.5906332E-07)*TEX+6.1293150E-04)*TEX+7.3816638E-02)
     3*TEX+3.0581530E+01
      SEF=+7.3816638E-02*ALOG(TEX)+((((((1.0382670E-25*TEX
     1-2.2226110E-21)*TEX+2.0425826E-17)*TEX-1.0512776E-13)*TEX
     2+3.3228928E-10)*TEX-6.8859505E-07)*TEX+1.2258630E-03)*TEX
     3+6.483398E-01
5     CPEX=(CPA+FARX*CPF)/(1.+FARX)
      HEX=(HEA+FARX*HEF)/(1.+FARX)
      PHI=(SEA+FARX*SEF)/(1.+FARX)
      AMW=28.97-.946186*FARX
      REX=1.986375/AMW
      AKEX=CPEX/(CPEX-REX)
      CSEX=SQRT(AKEX*REX*TEX*25031.37)
      RETURN
101   FORMAT(1H0,63HINPUT FUEL-AIR RATIO ABOVE LIMITS, IT HAS BEEN RESET
     2TO 0.067623,6H$$$$$$)
102   FORMAT(1H0,35HPROCOM INPUT TEMPERATURE BELOW 300.,6H$$$$$$)
103   FORMAT(1H0,36HPROCOM INPUT TEMPERATURE ABOVE 4000.,6H$$$$$$)
104   FORMAT(1H0,38HPROCOM INPUT FUEL-AIR RATIO BELOW ZERO,6H$$$$$$)
      END
      SUBROUTINE SEARCH(P,A,B,C,D,AX,NA,BX,CX,DX,NO,NAM,NOM,NCODE)
      DIMENSION AX(NAM),BX(NAM,NOM),CX(NAM,NOM),DX(NAM,NOM),NO(NAM),Q(9)
C *** NEEDS SUBROUTINE AFQUIR
C *** AX AND BX MUST BE STORED LO TO HI
C *** P=INPUT PROPORTION BETWEEN 0.0 AND 1.0
C     IF NOT INPUT, P MUST EQUAL -1.
C *** NCODE=00    OK
C     NCODE=01    A LO
C     NCODE=02    A HI
C     NCODE=07    ERROR
C     NCODE=10    B LO
C     NCODE=20    B HI
      NCODE=0
      C=0.
      D=0.
C *** FIND A
      DO 1 I=1,NA
      IH=I
      IF(A.LT.AX(I)) GO TO 2
1     CONTINUE
      IF(A.GT.AX(IH)) NCODE=2
      A=AX(IH)
      GO TO 3
2     IF(IH.GT.1) GO TO 3
      NCODE=1
      IH=2
      A=AX(1)
3     IL=IH-1
      LIMH=NO(IH)
      LIML=NO(IL)
C *** FIND B
      FRM=(A-AX(IL))/(AX(IH)-AX(IL))
      PP=P
      IF(P.GE.0.) GO TO 6
      BL=BX(IL,1)+FRM*(BX(IH,1)-BX(IL,1))
      BH=BX(IL,LIML)+FRM*(BX(IH,LIMH)-BX(IL,LIML))
      IF(B.GE.BL) GO TO 4
      NCODE=NCODE+10
      B=BL
      GO TO 5
4     IF(B.LE.BH) GO TO 5
      NCODE=NCODE+20
      B=BH
5     PP=0.5
      Q(2)=0.
      Q(3)=0.
6     BH=PP*(BX(IH,LIMH)-BX(IH,1))+BX(IH,1)
      BL=PP*(BX(IL,LIML)-BX(IL,1))+BX(IL,1)
      DO 7 J=2,LIMH
      JH=J
      IF(BH.LT.BX(IH,J)) GO TO 8
7     CONTINUE
8     JL=JH-1
      DO 9 K=2,LIML
      KH=K
      IF(BL.LT.BX(IL,K)) GO TO 10
9     CONTINUE
10    KL=KH-1

      PR=(BX(IH,JL)-BH)/(BX(IH,JH)-BX(IH,JL))
      CH= CX(IH,JL)-PR *(CX(IH,JH)-CX(IH,JL))
      DH= DX(IH,JL)-PR *(DX(IH,JH)-DX(IH,JL))

      PR=(BX(IL,KL)-BL)/(BX(IL,KH)-BX(IL,KL))
      CL= CX(IL,KL)-PR *(CX(IL,KH)-CX(IL,KL))
      DL= DX(IL,KL)-PR *(DX(IL,KH)-DX(IL,KL))

      BT=BL+PRM*(BH-BL)
      CT=CL+PRM*(CH-CL)
      DT=DL+PRM*(DH-DL)

      IF(P.[illegible]) GO TO 13
      DIR=SQRT(B/BT)
      ERR=(B-BT)/B
      CALL AFQUIR(Q(1),PP,ERR,0.,25.,0.001,DIR,PT,ICON)
      GO TO (11,11,12),ICON
11    PP=PT
      IF(PP.LT.0.) PP=0.
      IF(PP.GT.1.) PP=1.
      GO TO 6
12    MCODE=7
13    B=BT
      C=CT
      D=DT
      RETURN
      END
      SUBROUTINE CONVRG(TI,HI,PI,SI,FAR,WG,PA,IDES,AO,PR,
     1TO,HO,PO,SO,TSO,PSO,VO,AMO,ICON)
C     ICON=1      SUBSCNIC, COMPARE PI WITH PR
C     ICON=2      SONIC, COMPARE PI WITH PR
C     ICON=4      ERROR
      AJ=778.26
      CAPSF=2116.217
      G=32.174049
      CALL PROCOM(FAR,TI,XX1,XX2,XX3,XX4,PHII,XX6)

C *** SONIC CALCULATICNS

      J=0
      TSS=0.833*TI
1     J=J+1
      CALL PROCOM(FAR,TSS,CSS,AKS,CP,REXS,PHISS,HSS)
      HSCAL=HI-CSS**2/(2.*G*AJ)
      DELHS=HSCAL-HSS
      IF(ABS(DELHS)-0.0005*HSCAL)4,4,2
2     TSS=TSS+DELHS/CP
      IF(J-15)1,1,3
3     ICON=4
      RETURN
4     IF(IDES)12,12,5

C *** ISENTROPIC EXPANSION CALCULATIONS

5     J=0
      TSI=TI*(PA/PI)**0.286
6     J=J+1
      CALL THERMO(PA,HSI,TSI,SSI,XX1,1,FAR,0)
      IF(ABS(SSI-SI)-0.0001*SI)8,8,7
7     TSI=TSI/EXP(4.*(SSI-SI))
      IF(J-30)6,6,3
8     VIS=SQRT(2.*G*AJ*(HI-HSI))
      IF(VIS-CSS)9,11,11

C *** SUBSONIC DESIGN, CALCULATE AO

9     VO=VIS
      TSO=TSI
      PSO=PA
      CALL PROCOM(FAR,TSO,CSO,XX2,XX3,REX,PHISO,HSO)
      RHO=CAPSF*PSO/(AJ*REX*TSO)
      AO=WG/(RHO*VO)
      AMO=VO/CSO
      PR=PI
      ICON=1
10    TO=TI
      HO=HI
      PO=PI
      SO=SI
      RETURN

C *** SONIC DESIGN, CALCULATE AO
```

```
11      VO=CSS
        TSO=TSS
        PSO=PI*(TSO/TI)**(AKS/(AKS-1.))
        RHO=CAPSF*PSO/(AJ*REXS*TSO)
        AO=WG/(RHO*VO)
        AMO=1.0
        PR=PI
        ICON=2
        GO TO 10

C *** NON-DESIGN, CALCULATE CRITICAL CONDITIONS

12      VO=CSS
        TSO=TSS
        PSO=PA
        RHO=CAPSF*PSO/(AJ*REXS*TSO)
        AOCRIT=WG/(RHO*VO)
        AMO=1.0
        PR=PSO*(TI/TSO)**(AKS/(AKS-1.))
        IF(AO-AOCRIT)13,13,14

C *** NON-DESIGN, CRITICAL AND SUPERCRITICAL CONDITIONS

13      PSO=PSO*AOCRIT/AO
        PR=PR*AOCRIT/AO
        ICON=2
        GO TO 10

C *** NON-DESIGN, SUBSONIC CALCULATIONS

14      PSO=PA
        J=0
        TSO=0.833*TSO
15      J=J+1
        CALL PROCOM(FAR,TSO,CSO,AKO,CP,REX,PHISO,HSO)
        RHO=CAPSF*PSO/(AJ*REX*TSO)
        VO=WG/(RHO*AO)
        HSCAL=HI-VO**2/(2.*G*AJ)
        DELHS=HSCAL-HSO
        IF(ABS(DELHS)-0.0005*HSCAL)17,17,16
16      TSO=TSO+DELHS/CP
        IF(J-15)15,15,3
17      AMO=VO/CSO
        PR=PSO*(TI/TSO)**(AKO/(AKO-1.))
        ICON=1
        GO TO 10
        END
```

```
      SUBROUTINE CONDIV(TI,HI,PI,SI,FAR,WG,PA,IDES,AT,AO,PIR,
     1TT,HT,PT,ST,TO,HO,PO,SO,TST,TSO,PST,PSO,VT,VO,AMT,AMO,ICON)
C     ICON=1  SUBSONIC, COMPARE PIR WITH PI
C     ICON=2  SONIC, SHOCK INSIDE NOZZLE, COMPARE PIR WITH PI
C     ICON=3  SONIC, SHOCK OUTSIDE NOZZLE, COMPARE PIR WITH PI
C     ICON=4  ERROR
      DIMENSION Q(9)
      Q(2)=0.
      Q(3)=0.
      AJ=778.26
      CAPSF=2116.2170
      G=32.174049
      CALL PROCOM(FAR,TI,XX1,XX2,XX3,XX4,PHII,XX6)

C *** SONIC CALCULATIONS

      J=0
      TSS=0.833*TI
1     J=J+1
      CALL PROCOM(FAR,TSS,CSS,AK,CP,REXS,PHISS,HSS)
      HSCAL=HI-CSS**2/(2.*G*AJ)
      DELHS=HSCAL-HSS
      IF(ABS(DELHS)-0.0005*HSCAL)4,4,2
2     TSS=TSS+DELHS/CP
      IF(J-15)1,1,3
3     ICON=4
      RETURN
4     IF(IDES)11,11,5

C *** SONIC DESIGN, CALCULATE AT

5     VT=CSS
      TST=TSS
      PST=PI*(TST/TI)**(AK/(AK-1.))
      RHO=CAPSF*PST/(AJ*REXS*TST)
      AT=WG/(RHO*VT)
      AMT=1.0

C *** IDEAL EXPANSION DESIGN, CALCULATE AO

      PSO=PA
      J=0
      TSO=TI*(PSO/PI)**.286
6     J=J+1
      CALL PROCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
      PHICAL=PHII-REX*ALOG(PI/PSO)
      DELPHI=PHICAL-PHISO
      IF(ABS(DELPHI)-0.0001*PHICAL)8,8,7
7     TSO=TSO*EXP(4.*DELPHI)
      IF(J-15)6,6,3
8     VO=SQRT(2.*G*AJ*(HI-HSO))
      AMO=VO/CSO
      AO=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/(2.*
     1(AK-1.)))
      PIR=PI
      ICON=3
9     TO=TI
      HO=HI
      PO=PI
      SO=SI
10    TT=TI
      HT=HI
      PT=PI
      ST=SI
      RETURN

C *** ASSUME SONIC THROAT AND ISENTROPIC EXPANSION TO AO

11    V[illegible]
      AMT=1.0
      [illegible]=TSS
      RHO=WG/(AT*VT)
      PST=RHO*AJ*REXS*TST/CAPSF
      PIR=PST*(TI/TST)**(AK/(AK-1.))
      IF(PST-PA)12,24,24
12    TSO=0.95*TI
      MAM=0
13    CALL FROCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
      AMO=SQRT(2.*((TI/TSO)-1.)/(AK-1.))
      AOCAL=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/
     1(2.*(AK-1.)))
      EA=(AO-AOCAL)/AC
      DIR=SQRT(AO/AOCAL)
      CALL AFQUIR(Q(1),TSO,EA,0.,100.,0.0001,DIR,TSOT,JCON)
      GO TO (14,15,3),JCON
14    TSO=TSOT
      IF(TSC-TI)140,13,141
140   TSC=2.*TI/(AK+1.)
      IF(TSO.GT.TSC) GO TO 142
141   TSO=0.98*TI
      GO TO 13
142   IF(Q(2).LT.30.0.OR.AMO.LT.0.95.OR.MAM.EQ.1) GO TO 13
      TSO=2.*TI/(2.+0.98*(AK-1.))
      MAM=1
      GO TO 13
15    PSO=PIR*(TSO/TI)**(AK/(AK-1.))
      IF(PSO-PA)17,16,24
C *** CRITICAL FLOW, ISENTROPIC EXPANSION TO PA

16    VO=AMO*CSO
      ICON=1
      GO TO 9

C *** SUBSONIC FLOW

17    PSO=PA
      Q(2)=0.
      Q(3)=0.
      J=0
      TSO=0.833*TI
```

```
18      J=J+1
        CALL PROCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
        RHO=CAPSF*PSO/(AJ*REX*TSO)
        VO=WG/(RHO*AO)
        HSCAL=HI-VC**2/(2.*G*AJ)
        DELHS=HSCAL-HSO
        IF(ABS(DELHS)-0.0005*HSCAL)20,20,19
19      TSO=TSO+DELHS/CP
        IF(J-15)18,18,3
20      AMO=VO/CSO
        PIR=PSO*(TI/TSO)**(AK/(AK-1.))
        TST=TSO
21      CALL PROCOM(FAR,TST,CST,AK,CP,REX,PHIST,HST)
        PST=PIR*(TST/TI)**(AK/(AK-1.))
        RHO=PST*CAPSF/(AJ*REX*TST)
        VT=WG/(RHO*AT)
        HSCAL=HI-VT**2/(2.*G*AJ)
        EH=(HSCAL-HST)/HSCAL
        DIR=1.+(HSCAL-HST)/(CP*TST)
        CALL AFQUIR(Q(1),TST,EH,0.,20.,0.0005,DIR,TSTT,JCON)
        GO TO (22,23,3),JCON
22      TST=TSTT
        GO TO 21
23      AMT=VT/CST
        ICON=1
        GO TO 9

C *** SUPERCRITICAL FLOW, ISENTROPIC EXPANSION TO PA

24      PSO=PA
        J=0
        TSO=TI*(PSO/PIR)**.286
25      J=J+1
        CALL PROCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
        PHICAL=PHII-REX*ALOG(PIR/PSO)
        DELPHI=PHICAL-PHISO
        IF(ABS(DELPHI)-0.0001*PHICAL)27,27,26
26      TSO=TSO*EXP(4.0*DELPHI)
        IF(J-15)25,25,3
27      VO=SQRT(2.*G*AJ*(HI-HSO))
        AMO=VC/CSO
        AOID=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/
      1 (2.*(AK-1.)))
        ICON=3
        N=0
        IF(AO-AOID)28,9,29

C *** SUPERCRITICAL FLOW, ISENTROPIC EXPANSION TO AO

28      N=1
29      TSO=0.833*TI
        J=0
30      J=J+1
        CALL PROCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
        AMO=SQRT(2.*((TI/TSO)-1.)/(AK-1.))
      AOCAL=(AT/AMC)*(2.*(1.+(AK-1.)*AMC**2/2.)/(AK+1.))**((AK+1.)/
     1(2.*(AK-1.)))
      CELA=AO-AOCAL
      IF(ABS(DELA)-0.0001*AO)32,32,31
31    TSO=TSO*SQRT(AOCAL/AO)
      IF(J-50)30,30,3
32    IF(N)34,34,33

C *** UNDEREXPANCED, SHOCK OUTSIDE NOZZLE
33    PSO=PIR*(TSO/TI)**(AK/(AK-1.))

      VO=AMC*CSO
      GO TO 9

C *** OVEREXPANDED, FIND SHOCK POSITION

34    PSX=PIR*(TSO/TI)**(AK/(AK-1.))
      PSY=PSX*(2.*AK*AMO**2/(AK+1.)-(AK-1.)/(AK+1.))
      IF(PA-PSY)35,36,36

C *** OVEREXPANDED, SHOCK OUTSIDE NOZZLE

35    PSO=PSX
      VO=AMC*CSO
      GO TO 9

C *** OVEREXPANDED, SHOCK INSIDE NOZZLE

36    PSO=PA
      J=0
      TSO=0.833*TI
37    J=J+1
      CALL PRUCOM(FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)
      RHO=CAPSF*PSC/(AJ*REX*TSO)
      VO=WG/(RHO*AC)
      HSCAL=HI-VO**2/(2.*G*AJ)
      DELHS=HSCAL-HSO
      IF(ABS(DELHS)-0.0005*HSCAL)39,39,38
38    TSO=TSO+DELHS/CP
      IF(J-15)37,37,3
39    AMO=VC/CSO
      TO=TI
      HO=HI
      PO=PSO*(TO/TSO)**(AK/(AK-1.))
      SO=PHII-REX*ALOG(PO)
      ICON=2
      GO TO 10
      END
      SUBROUTINE AFQUIR(X,AIND,DEPEND,ANS,AJ,TOL,DIR,ANEW,ICON)
      DIMENSION X(9)
C X(1)=NAME OF ARRAY TO USE
C AIND=INDEPENDANT VARIABLE
C DEPEND= DEPENDANT VARIABLE
C ANS=ANSWER UPON WHICH TO CONVERGE
C AJ=MAX NUMBER OF TRYS
C TOL=PERCENT TOLERANCE FOR CONVERGENCE
C DIR=DIRECTION AND PERCENTAGE FOR FIRST GUESS
C ANEW=CALCULATED VALUE OF NEXT TRY AT INDEPENDANT VARIABLE
C ICON=CONTROL   =1 GO THRU LOOP AGAIN
C                =2 YOU HAVE REACHED THE ANSWER
C                =3 COUNTER HAS HIT LIMITS
C X(2)=COUNTER STORAGE
C X(3)=CHOOSES METHOD OF CONVERGENCE
C X(4)=THIRD DEPEND VAR
C X(5)=THIRD IND VAR
C X(6)=SECOND DEPEND VAR
C X(7)=SECOND INC VAR
C X(8)=FIRST DEPEND VAR
C X(9)=FIRST IND VAR
C X(3) MUST BE ZERO UPON FIRST ENTRY TO ROUTINE

      Y=0.
      IF(ANS)1,2,1
1     DEP=DEPEND-ANS
      TOLANS=TOL*ANS
      GO TO 3
2     DEP=DEPEND
      TOLANS=TOL
3     IF(ABS(DEP)-TOLANS)5,5,4
4     IF(X(2)-AJ)6,8,7
5     ANEW=AIND
      X(2)=0.
      ICON=2
      RETURN
6     ANEW=Y
      X(2)=X(2)+1.
      ICON=1
      RETURN
7     ANEW=Y
      X(2)=0.
      ICON=3
      RETURN
8     IF(X(3))9,9,12
C *** FIRST GUESS USING DIR
9     X(3)=1.
      X(8)=DEP
      X(9)=AIND
      IF(AIND)10,11,10
10    Y=DIR*AIND
      GO TO 6
11    Y=DIR
      GO TO 6
12    IF(X(3)-1.)13,13,16
```

```
C *** LINEAR GUESS
13     X(3)=2.
       X(6)=DEP
       X(7)=AIND
       IF(X(8)-X(6))14,9,14
14     IF(X(9)-X(7))15,9,15
15     A=(X(9)-X(7))/(X(8)-X(6))
       Y=X(9)-A*X(8)
       IF(ABS(10.*X(9))-ABS(Y))9,9,6
C *** QUADRATIC GUESS
16     X(4)=DEP
       X(5)=AIND
       IF(X(7)-X(5))18,17,18
17     IF(X(6)-X(4))13,9,13
18     IF(X(6)-X(4))19,13,19
19     IF(X(9)-X(5))23,20,23
20     IF(X(8)-X(4))21,22,21
21     X(9)=X(7)
       X(8)=X(6)
       GO TO 13
22     X(9)=X(7)
       X(8)=X(6)
       X(3)=1.
       IF(X(9))10,11,10
23     IF(X(8)-X(4))24,21,24
24     F=(X(6)-X(4))/(X(7)-X(5))
       A=(X(8)-X(4)-F*(X(9)-X(5)))/((X(9)-X(7))*(X(9)-X(5)))
       B=F-A*(X(5)+X(7))
       C=X(4)+X(5)*(A*X(7)-F)
       IF(A)242,240,242
240    IF(B)241,7,241
241    Y=-C/B
       GO TO 37
242    IF(B)247,243,247
243    IF(C)245,244,245
244    Y=0.
       GO TO 37
245    G=-C/A
       IF(G)7,7,246
246    Y=SQRT(G)
       YY=-SQRT(G)
       GO TO 270
247    IF(C)249,248,249
248    Y=-B/A
       YY=0.
       GO TO 270
249    D=4.*A*C/B**2
       IF(1.-D)13,25,26
25     Y=-B/(2.*A)
       GO TO 37
26     E=SQRT(1.-D)
27     Y=(-B/(2.*A))*(1.+E)
       YY=(-B/(2.*A))*(1.-E)
270    J=4
       DEPMIN=ABS(X(4))
```

```
      DO 29 I=6,8,2
      IF(DEPMIN-ABS(X(I)))29,29,28
28    J=I
      DEPMIN=ABS(X(I))
29    CONTINUE
      K=J+1
      IF((X(K)-Y)*(X(K)-YY))32,32,30
30    IF(ABS(X(K)-Y)-ABS(X(K)-YY))37,37,31
31    Y=YY
      GO TO 37
32    IF(J-6)33,34,34
33    JJ=J+2
      KK=K+2
      GO TO 35
34    JJ=J-2
      KK=K-2
35    SLOPE=(X(KK)-X(K))/(X(JJ)-X(J))
      IF(SLCPE*X(J)*(X(K)-Y))36,36,37
36    Y=YY
37    X(9)=X(7)
      X(8)=X(6)
      X(7)=X(5)
      X(6)=X(4)
      GO TO 6
      END
      SUBROUTINE MATRIX(E,V,A)
      DIMENSION E(9,9),V(9),A(9),PIV(10),T(9,10)
      DO 1 I=1,9
      T(I,10)=A(I)
      DO 1 J=1,9
1     T(I,J)=E(I,J)
      DO 7 I=1,9
      TEMP=0.
      DO 2 J=I,9
      IF(TEMP.GT.ABS(T(J,I))) GO TO 2
      TEMP=ABS(T(J,I))
      IPIV=J
2     CONTINUE
      IP1=I+1
      DO 3 J=IP1,10
3     PIV(J)=T(IPIV,J)/T(IPIV,I)
      IFROM=9
      ITO=9
4     IF(IFROM.EQ.IPIV) GO TO 6
      RM=-T(IFROM,I)
      DO 5 J=IP1,10
5     T(ITO,J)=T(IFROM,J)+RM*PIV(J)
      ITO=ITO-1
6     IFROM=IFROM-1
      IF(IFROM.GE.I) GO TO 4
      DO 7 J=IP1,10
7     T(I,J)=PIV(J)
      DO 8 I=1,8
      J=10-I
      K=9-I
      DO 8 L=J,9
8     T(K,10)=T(K,10)-T(K,L)*T(L,10)
      DO 9 I=1,9
9     V(I)=T(I,10)
      RETURN
      END
      SUBROUTINE OUTPUT
      DIMENSION W(5,4),ANS1(96),ANS2(121),ANS3(56),ANS4(72)
      COMMON /   ALL/
     1WORD   ,IDES   ,JDES   ,KDES   ,MODE   ,INIT   ,IDUMP  ,IAMTP  ,
     2IGASMX,IOBURN,IAFTBN,IDCO   ,IMCO   ,IDSHOC,IMSHOC,NOZFLT,
     3ITRYS,LOOPER,NOMAP,NUMMAP,MAPEDG,TOLALL,ERR(9)
      COMMON/DESIGN/
     1PCNFGU ,PCNIGU ,PCNCGU ,T4GU   ,DUMD1  ,DELFG  ,DELFN  ,DELSFC ,
     2ZFDS   ,PCNFDS ,PRFDS  ,ETAFDS ,WAFDS  ,PRFCF  ,ETAFCF ,WAFCF  ,
     3ZIDS   ,PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,
     4ZCDS   ,PCNCDS ,PRCDS  ,ETACDS ,WACDS  ,PRCCF  ,ETACCF ,WACCF  ,
     5T4DS   ,WFBDS  ,DTCODS ,ETABDS ,WA3CDS ,DPCODS ,DTCOCF ,ETABCF ,
     6TFHPDS ,CNHPDS ,ETHPDS ,TFHPCF ,CNHPCF ,ETHPCF ,DHHPCF ,T2DS   ,
     7TFIPDS ,CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETIPCF ,DHIPCF ,T21DS  ,
     8TFLPDS ,CNLPDS ,ETLPDS ,TFLPCF ,CNLPCF ,ETLPCF ,DHLPCF ,T22DS  ,
     9T24DS  ,WFDDS  ,DTDUDS ,ETADDS ,WA23DS ,DPDUDS ,DTDUCF ,ETADCF ,
     AT7DS   ,WFADS  ,DTAFDS ,ETAADS ,WG6CDS ,DPAFDS ,DTAFCF ,ETAACF ,
     BA55    ,A25    ,A6     ,A7     ,A8     ,A9     ,A28    ,A29    ,
     CPS55   ,AM55   ,CVDNOZ ,CVMNOZ ,A8SAV  ,A9SAV  ,A28SAV ,A29SAV
      COMMON/ FRONT/
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
     2T21    ,P21    ,H21    ,S21    ,T22    ,P22    ,H22    ,S22    ,
     3T3     ,P3     ,H3     ,S3     ,T4     ,P4     ,H4     ,S4     ,
     4T45    ,P45    ,H45    ,S45    ,T5     ,P5     ,H5     ,S5     ,
     5T55    ,P55    ,H55    ,S55    ,BLF    ,BL1    ,BLC    ,BLDU   ,
     6CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,BLDUI  ,BLDUC  ,BLOB   ,
     7CNI    ,PRI    ,ETAI   ,WAIC   ,WAI    ,BLOBI  ,BLOBC  ,WA3    ,
     8CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,WG4    ,
     9CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,BLHPI  ,BLHPC  ,FAR4   ,
     ACNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,BLIPI  ,BLIPC  ,DUMF   ,
     BCNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,BLLPI  ,BLLPC  ,CS     ,
     CWG45   ,FAR45  ,WG5    ,FAR5   ,WG55   ,FAR55  ,HPEXT  ,AM     ,
     DALTP   ,ETAR   ,ZF     ,PCNF   ,ZI     ,PCNI   ,ZC     ,PCNC   ,
     EWFB    ,TFFHP  ,TFFIP  ,TFFLP  ,PCBLF  ,PCBLI  ,PCBLC  ,PCBLDUI,
     FPCBLDUC,PCBLCBI,PCBLOBC,PCBLHPI,PCBLHPC,PCBLIPI,PCBLIPC,PCBLLPI,
     GPCBLLPC
      COMMON/  SIDE/
     1XP1    ,XWAF   ,XWAI   ,XWAC   ,XBLF   ,XBLDU  ,XBLDUI ,XBLDUC ,
     2XH22   ,XH3    ,XT21   ,XP21   ,XH21   ,XS21   ,DUMS1  ,DUMS2  ,
     3T23    ,P23    ,H23    ,S23    ,T24    ,P24    ,H24    ,S24    ,
     4T25    ,P25    ,H25    ,S25    ,T28    ,P28    ,H28    ,S28    ,
     5T29    ,P29    ,H29    ,S29    ,DUMS3  ,DUMS4  ,DUMS5  ,DUMS6  ,
     6WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS7  ,
     7TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
      COMMON /  BACK/
     XXT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,
     XXWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUM8  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      EQUIVALENCE (ANS1(1),PCNFGU),(ANS2(1),T1),(ANS3(1),XP1)
      EQUIVALENCE (ANS4(1),XT55)
      DATA AWORD1,AWORD2/6HOUTPUT,6HCOMMON/
      DATA (W(1,I),I=1,4)/6HSUBSON,6HIC C-D,6H NOZZL,6HE     /
      DATA (W(2,I),I=1,4)/6HSHOCK ,6HINSIDE,6H C-D N,6HOZZLE /
      DATA (W(3,I),I=1,4)/6HSHOCK ,6HOUTSID,6HE C-D ,6HNOZZLE/
      DATA (W(4,I),I=1,4)/6HSUBSON,6HIC CON,6HVERG. ,6HNOZZLE/
      DATA (W(5,I),I=1,4)/6HSONIC ,6HCONVER,6HGENT N,6HOZZLE /
      WORD=AWORD1
      IF(IDES.EQ.1) GO TO 4
      IF(IDBURN.GT.0) GO TO 2
      IF(IAFTBN.GT.0) GO TO 1
      WRITE(6,100)WORD,AM,ALTP,T4,ETAR
      GO TO 3
1     WRITE(6,101)WORD,AM,ALTP,T4,T7,ETAR
      GO TO 3
2     WRITE(6,102)WORD,AM,ALTP,T4,T24,ETAR
3     CALL CONOUT(2)
4     WRITE(6,104)(W(IMSHOC,I),I=1,4),FG,FN,SFC
      IF(IGASMX.GT.0) GO TO 5
      WRITE(6,105)(W(IDSHOC,I),I=1,4)
5     WRITE(6,106)LOOPER
      WORD=AWORD2
      WRITE(6,107)WORD,ZF,PCNF,ZI,PCNI,ZC,PCNC,T4,MODE
      WRITE(6,108)
      WRITE(6,109) (ANS1(I),I=1,96)
      WRITE(6,108)
      WRITE(6,109) (ANS2(I),I=1,121)
      WRITE(6,108)
      WRITE(6,109) (ANS3(I),I=1,56)
      WRITE(6,108)
      WRITE(6,109) (ANS4(I),I=1,72)
      IF(IDES.EQ.1) GO TO 6
      A8=A8SAV
      A9=A9SAV
      A28=A28SAV
      A29=A29SAV
      IF(IDUMP.NE.2) GO TO 6
      WRITE(6,110)
      CALL SYG(2)
6     CALL ENGBAL
      RETURN
100   FORMAT(1H0,A6,14X7H     AM=, F7.3, 6X7H  ALTP=,F7.0,
     16X7H    T4=,F8.2,25X7H  ETAR=,F7.4)
101   FORMAT(1H0,A6,14X7H     AM=, F7.3, 6X7H  ALTP=,F7.0,
     16X7H    T4=,F8.2,5X7H    T7=,F8.2,5X7H  ETAR=,F7.4)
102   FORMAT(1H0,A6,14X7H     AM=, F7.3, 6X7H  ALTP=,F7.0,
     16X7H    T4=,F8.2,5X7H   T24=,F8.2,5X7H  ETAR=,F7.4)
104   FORMAT(6H0MAIN ,4A6,9X3HFG=,F9.2,18X3HFN=,F9.2,18X4HSFC=,F8.5)
105   FORMAT(6H CUCT ,4A6)
106   FORMAT(16H1CCNVERGED AFTER,I4,6H LOOPS,/,1H0)
107   FORMAT(1H ,A6,9X,7E15.6,I4)
108   FORMAT(1H )
109   FORMAT(1H ,8E15.6)
110   FORMAT(1H1)
      END
      SUBROUTINE MAPBAC(MAP,MAPGO,TFFS,TFF,CNS,CN,PCN,T,MODE,IGO,NUM)
      DATA WH,WI,WL,WT,WS/6H H.P. ,6H I.P. ,6H L.P. ,6H TFF  ,6HSPEED /
1     FORMAT(1H0,A6,12HTURBINE MAP ,A6,4HWAS=,E13.6,10H  AND NOW=,E13.6,
     16H$$$$$$)
2     FORMAT(1H0,A6,A6,22HWAS ALSO CHANGED FROM ,E13.6,5H  TO ,E13.6,
     16H$$$$$$)
      IF(NUM.GT.0) GO TO 3
      NUMH=0
      NUMI=0
      NUML=0
3     IGO=MAPGO+3*(MAP-1)
      GO TO (100,200,300,400,500,600,700,800,900),IGO
C *** HIGH PRESSURE TURBINE
100   TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WH,WT,TFFS,TFF
      RETURN
200   CN=CN+0.05*(CN-CNS)
      IF(MODE.NE.1) PCN=PCN*(CN/CNS)
      IF(MODE.EQ.1) T   =T   *(CNS/CN)**2
      WRITE(8,1) WH,WS,CNS,CN
      IF(NUMH.GT.2) GO TO 210
      NUM=1
      NUMH=NUMH+1
      RETURN
210   DELCN=CN-CNS
      IF(DELCN.GE.0.) RETURN
      TFF=TFF*(1.+DELCN/CN)
      WRITE(8,2) WH,WT,TFFS,TFF
      RETURN
300   TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WH,WT,TFFS,TFF
      GO TO 200
C *** LOW PRESSURE TURBINE
400   TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WL,WT,TFFS,TFF
      RETURN
500   CN=CN+0.05*(CN-CNS)
      IF(MODE.NE.3) PCN=PCN*(CN/CNS)
      IF(MODE.EQ.3) T   =T   *(CNS/CN)
      WRITE(8,1) WL,WS,CNS,CN
      IF(NUML.GT.2) GO TO 510
      NUM=1
      NUML=NUML+1
      RETURN
510   DELCN=CN-CNS
      IF(DELCN.GE.0.) RETURN
      TFF=TFF*(1.+DELCN/CN)
      WRITE(8,2) WL,WT,TFFS,TFF
      RETURN
600   TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WL,WT,TFFS,TFF
      GO TO 500
C *** INTERMEDIATE SPOOL TURBINE
 700  TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WI,WT,TFFS,TFF
      RETURN
800   CN=CN+0.05*(CN-CNS)
      IF(MODE.NE.3) PCN=PCN*(CN/CNS)
      IF(MODE.EQ.3) T=T*(CNS/CN)
      WRITE(8,1) WI,WS,CNS,CN
      IF(NUMI.GT.2) GO TO 810
      NUM=1
      NUMI=NUMI+1
      RETURN
810   DELCN=CN-CNS
      IF(DELCN.GE.0.) RETURN
      TFF=TFF*(1.+DELCN/CN)
      WRITE(8,2) WI,WT,TFFS,TFF
      RETURN
900   TFF=TFF+0.1*(TFF-TFFS)
      WRITE(8,1) WI,WT,TFFS,TFF
      GO TO 800
      END
      SUBROUTINE THERMO(PX,HX,TX,SX,AMX,L,FAR,K)
      FX=0.
      IF(L.EQ.1) FX=FAR
      IF(K.EQ.1) GO TO 1
      CALL PROCOM(FX,TX,CS,AK,CP,R,PHI,HX)
      GO TO 3
1     TX=4.*HX
      DO 2 I=1,15
      CALL PROCOM(FX,TX,CS,AK,CP,R,PHI,H)
      DELH=HX-H
      IF(ABS(DELH).LE.0.00001*HX) GO TO 3
2     TX=TX+4.*DELH
      WRITE(6,100)
100   FORMAT(31H0NO CONVERGENCE IN THERMO$$$$$$)
3     SX=PHI-R*ALOG(PX)
      AMX=1.986375/R
      RETURN
      END
      SUBROUTINE RAM(AM,ETAR)
      IF(AM.GT.1.) GO TO 2
      ETAR=1.
 1    RETURN
 2    IF(AM.GT.5.) GO TO 3
      ETAR=1.-0.075*((AM-1.)**1.35)
      GO TO 1
 3    ETAR=800./((AM**4)+935.)
      GO TO 1
      END
```

```
FUNCTION GUESS(M,T,TD,P,PD,W,WD,D,DD,VD)
IF(M.EQ.0) GUESS=VD*((T/TD)**1.60)*((DD/D)**0.50)
IF(M.EQ.1) GUESS=VD*((P/PD)**1.80)*((DD/D)**0.33)
IF(M.EQ.2) GUESS=VD*((W/WD)**0.33)*((DD/D)**1.00)
IF(M.EQ.3) GUESS=VD*((W/WD)**0.00)*((P/PD)**0.50)
IF(M.EQ.4) GUESS=VD*((W/WD)**0.00)*((P/PD)**0.50)
IF(M.EQ.5) GUESS=VD*((T/TD)**1.10)*((DD/D)**0.60)
IF(M.EQ.6) GUESS=VD*((P/PD)**1.00)*((D/DD)**0.25)
IF(M.EQ.7) GUESS=VD*((P/PD)**0.62)*((D/DD)**0.31)
IF(M.EQ.8) GUESS=VD*((T/TD)**1.2)*DD/D
IF(M.EQ.9) GUESS=VD*P/PD*((D/DD)**1.5)
RETURN
END
```

```
 BLOCK DATA CMBDAT
 COMMON / COMB/PSI(15),DELT(15,15),ETA(15,15),N,NP(15)
 DATA N,NP/15,15*15/
 DATA PSI/4.9116,9.8232,14.735,19.646,24.558,29.470,34.381,
139.293,44.207,73.674,100.,200.,300.,400.,500./
 DATA DELT/15*200.,15*300.,15*400.,15*500.,15*600.,15*700.,15*800.
115*900.,15*1000.,15*1100.,15*1200.,15*1300.,15*1400.,15*1500.,
215*1600./
 DATA ETA/
1.600,.726,.777,.806,.826,.843,.855,.865,7*.870,
2.758,.825,.858,.875,.888,.898,.906,.912,.914,6*.915,
3.868,.893,.911,.925,.935,.942,.947,.951,7*.953,
4.925,.936,.946,.955,.963,.969,.974,.977,.978,6*.979,
5.960,.966,.972,.977,.982,.985,.990,.992,.993,6*.995,
6.988,.991,.992,.994,.995,.997,.998,8*.999,
78*1.00,7*.999,120*1.00/
  END
```

```
      BLOCK DATA FANDAT
C     THIS IS A GENERALIZED FAN MAP FOR UNREALISTIC SUPERSONIC ENGINE
      COMMON/  FAN/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/10,6,3*7,5*10,8,5*0/
      DATA CN/0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,5*0./
       DATA (PR(1,J)   ,J=1,6 )/
     C1.0000 ,1.0120 ,1.0280 ,1.0384 ,1.0448 ,1.0480 /
       DATA (WAC(1,J)  ,J=1,6 )/
     C243.60 ,229.80 ,199.80 ,166.80 ,133.20 ,86.400 /
       DATA (ETA(1,J)  ,J=1,6 )/
     C0.7559 ,0.7612 ,0.7665 ,0.7559 ,0.7251 ,0.6415 /
       DATA (PR(2,J)   ,J=1,7 )/
     C1.0000 ,1.0200 ,1.0400 ,1.0584 ,1.0752 ,1.0920 ,1.1000 /
       DATA (WAC(2,J)  ,J=1,7 )/
     C286.80 ,270.00 ,253.20 ,233.40 ,209.40 ,183.60 ,156.60 /
       DATA (ETA(2,J)  ,J=1,7 )/
     C0.7559 ,0.7762 ,0.7920 ,0.7973 ,0.3026 ,0.7762 ,0.7401 /
       DATA (PR(3,J)   ,J=1,7 )/
     C1.0000 ,1.0256 ,1.0512 ,1.0800 ,1.1160 ,1.1320 ,1.1480 /
       DATA (WAC(3,J)  ,J=1,7 )/
     C333.60 ,322.80 ,310.20 ,291.60 ,259.80 ,240.00 ,213.60 /
       DATA (ETA(3,J)  ,J=1,7 )/
     C0.7506 ,0.7762 ,0.8026 ,0.8281 ,0.8439 ,0.8281 ,0.7662 /
       DATA (PR(4,J)   ,J=1,7 )/
     C1.0000 ,1.0368 ,1.0880 ,1.1240 ,1.1600 ,1.1896 ,1.1952 /
       DATA (WAC(4,J)  ,J=1,7 )/
     C383.40 ,376.20 ,358.20 ,340.20 ,313.20 ,276.60 ,266.40 /
       DATA (ETA(4,J)  ,J=1,7 )/
     C0.7454 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.8281 ,0.8078 /
       DATA (PR(5,J)   ,J=1,10)/
     C1.0000 ,1.0640 ,1.1184 ,1.1480 ,1.1840 ,1.2096 ,1.2176 ,
     C1.2240 ,1.2440 ,1.2672 /
       DATA (WAC(5,J)  ,J=1,10)/
     C439.80 ,436.80 ,428.40 ,420.60 ,406.80 ,393.60 ,388.20 ,
     C383.40 ,368.40 ,342.60 /
       DATA (ETA(5,J)  ,J=1,10)/
     C0.7251 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.9011 ,0.9038 ,
     C0.9011 ,0.8800 ,0.8281 /
       DATA (PR(6,J)   ,J=1,10)/
     C1.0000 ,1.1000 ,1.1600 ,1.2000 ,1.2280 ,1.2552 ,1.2720 ,
     C1.2864 ,1.3024 ,1.3320 /
       DATA (WAC(6,J)  ,J=1,10)/
     C499.81 ,499.80 ,493.20 ,485.40 ,476.40 ,466.80 ,456.60 ,
     C448.20 ,433.20 ,406.80 /
       DATA (ETA(6,J)  ,J=1,10)/
     C0.6882 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.9011 ,0.9108 ,
     C0.9011 ,0.8800 ,0.8272 /
       DATA (PR(7,J)   ,J=1,10)/
     C1.0000 ,1.0760 ,1.1520 ,1.2192 ,1.2600 ,1.2896 ,1.3312 ,
     C1.3616 ,1.3912 ,1.4000 /
       DATA (WAC(7,J)  ,J=1,10)/
     C566.41 ,566.40 ,566.39 ,559.80 ,553.20 ,544.80 ,528.60 ,
     C509.40 ,483.60 ,474.00 /
       DATA (ETA(7,J)  ,J=1,10)/
     C0.6415 ,0.7251 ,0.7762 ,0.8281 ,0.8589 ,0.8800 ,0.9011 ,
C0.8800 ,0.8281 ,0.8175 /
 DATA (PR(8,J)  ,J=1,10)/
C1.0000 ,1.0440 ,1.1352 ,1.2208 ,1.2944 ,1.3400 ,1.4000 ,
C1.4280 ,1.4480 ,1.4800 /
 DATA (WAC(8,J) ,J=1,10)/
C633.61 ,633.60 ,633.59 ,633.00 ,625.80 ,616.80 ,600.00 ,
C586.80 ,576.60 ,553.20 /
 DATA (ETA(8,J) ,J=1,10)/
C0.6002 ,0.6415 ,0.7251 ,0.7762 ,0.8281 ,0.8589 ,0.8800 ,
C0.8589 ,0.8281 ,0.7867 /
 DATA (PR(9,J)  ,J=1,10)/
C1.0000 ,1.1040 ,1.2200 ,1.3240 ,1.4000 ,1.4480 ,1.5000 ,
C1.5336 ,1.5680 ,1.5840 /
 DATA (WAC(9,J) ,J=1,10)/
C700.22 ,700.21 ,700.20 ,700.19 ,700.18 ,698.40 ,693.60 ,
C683.40 ,666.60 ,656.40 /
 DATA (ETA(9,J) ,J=1,10)/
C0.5694 ,0.6415 ,0.7251 ,0.7762 ,0.8026 ,0.8078 ,0.8026 ,
C0.7762 ,0.7454 ,0.7251 /
 DATA (PR(10,J) ,J=1,8 )/
C1.0000 ,1.1632 ,1.3120 ,1.4000 ,1.4800 ,1.5400 ,1.5800 ,
C1.6600 /
 DATA (WAC(10,J),J=1,8 )/
C750.03 ,750.02 ,750.01 ,750.00 ,749.99 ,749.98 ,749.40 ,
C736.80 /
 DATA (ETA(10,J),J=1,8 )/
C0.5174 ,0.6415 ,0.7251 ,0.7559 ,0.7612 ,0.7586 ,0.7251 ,
C0.6415 /
 END
```

```
      BLOCK DATA INTDAT
C     THIS IS A GENERALIZED INT. COMP. MAP FOR UNREALISTIC SUPERSONIC EN
      COMMON/  INT/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/10,6,3*7,5*10,8,5*0/
      DATA CN/0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,5*0./
      DATA (PR(1,J)   ,J=1,6 )/
     C1.0000 ,1.0180 ,1.0420 ,1.0576 ,1.0672 ,1.0720 /
      DATA (WAC(1,J) ,J=1,6 )/
     C121.80 ,114.90 ,99.900 ,83.400 ,66.600 ,43.200 /
      DATA (ETA(1,J) ,J=1,6 )/
     C0.7559 ,0.7612 ,0.7665 ,0.7559 ,0.7251 ,0.6415 /
      DATA (PR(2,J)   ,J=1,7 )/
     C1.0000 ,1.0300 ,1.0600 ,1.0876 ,1.1128 ,1.1380 ,1.1500 /
      DATA (WAC(2,J) ,J=1,7 )/
     C143.40 ,135.00 ,126.60 ,116.70 ,104.70 ,91.800 ,78.300 /
      DATA (ETA(2,J) ,J=1,7 )/
     C0.7559 ,0.7762 ,0.7420 ,0.7973 ,0.8026 ,0.7762 ,0.7401 /
      DATA (PR(3,J)   ,J=1,7 )/
     C1.0000 ,1.0384 ,1.0768 ,1.1200 ,1.1740 ,1.1980 ,1.2220 /
      DATA (WAC(3,J) ,J=1,7 )/
     C166.80 ,161.40 ,155.10 ,145.80 ,129.90 ,120.00 ,106.80 /
      DATA (ETA(3,J) ,J=1,7 )/
     C0.7506 ,0.7762 ,0.8026 ,0.8281 ,0.8439 ,0.8281 ,0.7762 /
      DATA (PR(4,J)   ,J=1,7 )/
     C1.0000 ,1.0552 ,1.1320 ,1.1860 ,1.2400 ,1.2844 ,1.2928 /
      DATA (WAC(4,J) ,J=1,7 )/
     C191.70 ,188.10 ,179.10 ,170.10 ,156.60 ,138.30 ,133.20 /
      DATA (ETA(4,J) ,J=1,7 )/
     C0.7454 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.8281 ,0.8078 /
      DATA (PR(5,J)   ,J=1,10)/
     C1.0000 ,1.0960 ,1.1776 ,1.2220 ,1.2760 ,1.3144 ,1.3264 ,
     C1.3360 ,1.3660 ,1.4008 /
      DATA (WAC(5,J) ,J=1,10)/
     C219.90 ,218.40 ,214.20 ,210.30 ,203.40 ,196.80 ,194.10 ,
     C191.70 ,184.20 ,171.30 /
      DATA (ETA(5,J) ,J=1,10)/
     C0.7251 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.9011 ,0.9038 ,
     C0.9011 ,0.8800 ,0.8281 /
      DATA (PR(6,J)   ,J=1,10)/
     C1.0000 ,1.1500 ,1.2409 ,1.3000 ,1.3420 ,1.3828 ,1.4080 ,
     C1.4296 ,1.4536 ,1.4980 /
      DATA (WAC(6,J) ,J=1,10)/
     C249.91 ,249.90 ,246.60 ,242.70 ,238.20 ,233.40 ,228.30 ,
     C224.10 ,216.60 ,203.40 /
      DATA (ETA(6,J) ,J=1,10)/
     C0.6882 ,0.7762 ,0.8281 ,0.8545 ,0.8800 ,0.9011 ,0.9108 ,
     C0.9011 ,0.8800 ,0.8272 /
      DATA (PR(7,J)   ,J=1,10)/
     C1.0000 ,1.1140 ,1.2280 ,1.3288 ,1.3900 ,1.4344 ,1.4968 ,
     C1.5424 ,1.5868 ,1.6000 /
      DATA (WAC(7,J) ,J=1,10)/
     C283.21 ,283.20 ,283.19 ,279.90 ,276.60 ,272.40 ,264.30 ,
     C254.70 ,241.80 ,237.00 /
      DATA (ETA(7,J) ,J=1,10)/
     C0.6415 ,0.7251 ,0.7762 ,0.8281 ,0.8589 ,0.8800 ,0.9011 ,
C0.8800 ,0.8281 ,0.8175 /
 DATA (PR(8,J)  ,J=1,10)/
C1.0000 ,1.0660 ,1.2028 ,1.3312 ,1.4416 ,1.5100 ,1.6000 ,
C1.6420 ,1.6720 ,1.7200 /
 DATA (WAC(8,J) ,J=1,10)/
C316.81 ,316.80 ,316.79 ,316.50 ,312.90 ,308.40 ,300.00 ,
C293.40 ,288.30 ,276.60 /
 DATA (ETA(8,J) ,J=1,10)/
C0.6002 ,0.6415 ,0.7251 ,0.7762 ,0.8281 ,0.8589 ,0.8800 ,
C0.8589 ,0.8281 ,0.7867 /
 DATA (PR(9,J)  ,J=1,10)/
C1.0000 ,1.1560 ,1.3300 ,1.4860 ,1.6000 ,1.6720 ,1.7500 ,
C1.8004 ,1.8520 ,1.8760 /
 DATA (WAC(9,J) ,J=1,10)/
C350.12 ,350.11 ,350.10 ,350.09 ,350.08 ,349.20 ,346.80 ,
C341.70 ,333.30 ,328.20 /
 DATA (ETA(9,J) ,J=1,10)/
C0.5694 ,0.6415 ,0.7251 ,0.7762 ,0.8026 ,0.8078 ,0.8026 ,
C0.7762 ,0.7454 ,0.7251 /
 DATA (PR(10,J) ,J=1,8 )/
C1.0000 ,1.2448 ,1.4680 ,1.6000 ,1.7200 ,1.8100 ,1.8700 ,
C1.9900 /
 DATA (WAC(10,J),J=1,8 )/
C375.03 ,375.02 ,375.01 ,375.00 ,374.99 ,374.98 ,374.70 ,
C368.40 /
 DATA (ETA(10,J),J=1,8 )/
C0.5174 ,0.6415 ,0.7251 ,0.7559 ,0.7612 ,0.7506 ,0.7251 ,
C0.6415 /
 END
```

```
      BLOCK DATA CMPDAT
C     THIS IS A GENERALIZED H.P. COMP. MAP FOR UNREALISTIC SUPERSONIC EN
      COMMON/ COMP/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/10,2*6,2*8,4*10,2*8,5*0/
      DATA CN/.562,.674,.787,.899,1.,1.034,1.067,1.124,1.236,1.292,5*0./
      DATA (PR(1,J)   ,J=1,6 )/
     C1.0000 ,1.8400 ,2.4280 ,2.8690 ,3.8350 ,4.5490 /
      DATA (WAC(1,J) ,J=1,6 )/
     C51.000 ,50.200 ,49.500 ,48.800 ,46.700 ,44.500 /
      DATA (ETA(1,J) ,J=1,6 )/
     C0.5908 ,0.6218 ,0.6424 ,0.6527 ,0.6734 ,0.6424 /
      DATA (PR(2,J)   ,J=1,6 )/
     C1.0000 ,1.9660 ,3.0930 ,3.9330 ,4.6890 ,5.5290 /
      DATA (WAC(2,J) ,J=1,6 )/
     C59.300 ,59.299 ,58.800 ,57.900 ,56.700 ,55.000 /
      DATA (ETA(2,J) ,J=1,6 )/
     C0.5908 ,0.6424 ,0.6940 ,0.7250 ,0.7456 ,0.7250 /
      DATA (PR(3,J)   ,J=1,8 )/
     C1.0000 ,1.8400 ,2.6800 ,3.4080 ,4.5210 ,5.4450 ,6.3130 ,
     C6.5230 /
      DATA (WAC(3,J) ,J=1,8 )/
     C70.00_ ,70.000 ,69.999 ,69.500 ,68.800 ,67.900 ,66.400 ,
     C65.700 /
      DATA (ETA(3,J) ,J=1,8 )/
     C0.5857 ,0.6424 ,0.6837 ,0.7250 ,0.7774 ,0.7929 ,0.7774 ,
     C0.7697 /
      DATA (PR(4,J)   ,J=1,8 )/
     C1.0000 ,2.0080 ,3.4290 ,4.6050 ,5.6970 ,6.6140 ,7.5380 ,
     C7.9580 /
      DATA (WAC(4,J) ,J=1,8 )/
     C84.802 ,84.801 ,84.800 ,84.799 ,84.000 ,83.300 ,81.700 ,
     C80.500 /
      DATA (ETA(4,J) ,J=1,8 )/
     C0.5805 ,0.6424 ,0.7250,0.7774  ,0.8084 ,0.8290 ,0.80 4 ,
     C0.7929 /
      DATA (PR(5,J)   ,J=1,10)/
     C1.0000 ,2.5190 ,3.9820 ,5.2770 ,6.4880 ,7.2020 ,8.0000 ,
     C8.5670 ,9.3860 ,9.5960 /
      DATA (WAC(5,J) ,J=1,10)/
     C101.72 ,101.71 ,101.70 ,101.69 ,101.20 ,101.00 ,100.00 ,
     C99.500 ,98.100 ,97.400 /
      DATA (ETA(5,J) ,J=1,10)/
     C0.5719 ,0.6424 ,0.7250 ,0.7774 ,0.8084 ,0.8394 ,0.8600 ,
     C0.8394 ,0.8084 ,0.8058 /
      DATA (PR(6,J)   ,J=1,10)/
     C1.0000 ,2.8550 ,4.2970 ,5.6130 ,6.9360 ,7.6220 ,8.5460 ,
     C9.1340 ,9.9250 ,10.2190/
      DATA (WAC(6,J) ,J=1,10)/
     C108.12 ,108.11 ,108.10 ,108.09 ,107.60 ,107.10 ,106.70 ,
     C106.00 ,104.50 ,104.00 /
      DATA (ETA(6,J) ,J=1,10)/
     C0.5702 ,0.6424 ,0.7250 ,0.7774 ,0.8084 ,0.8394 ,0.8600 ,
     C0.8394 ,0.8084 ,0.8041 /
      DATA (PR(7,J)   ,J=1,10)/
     C1.0000 ,3.2610 ,4.7590 ,6.1170 ,7.4540 ,8.3080 ,9.2180 ,
C9.6380 ,10.513 ,10.996 /
 DATA (WAC(7,J) ,J=1,10)/
C114.52 ,114.51 ,114.50 ,114.49 ,114.48 ,114.30 ,113.60 ,
C113.30 ,112.60 ,112.40 /
 DATA (ETA(7,J) ,J=1,10)/
C0.5599 ,0.6424 ,0.7250 ,0.7774 ,0.8084 ,0.8394 ,0.8497 ,
C0.8394 ,0.8084 ,0.7981 /
 DATA (PR(8,J)  ,J=1,10)/
C1.0000 ,1.6860 ,3.8490 ,5.4660 ,6.8660 ,8.3710 ,8.9660 ,
C9.8830 ,10.912 ,11.815 /
 DATA (WAC(8,J) ,J=1,10)/
C122.93 ,122.92 ,122.91 ,122.90 ,122.89 ,122.88 ,122.60 ,
C122.10 ,121.70 ,120.70 /
 DATA (ETA(8,J) ,J=1,10)/
C0.5392 ,0.5702 ,0.6424 ,0.7250 ,0.7774 ,0.8084 ,0.8239 ,
C0.8394 ,0.8084 ,0.7774 /
 DATA (PR(9,J)  ,J=1,8 )/
C1.0000 ,4.3530 ,7.6220 ,10.219 ,11.059 ,11.899 ,13.159 ,
C13.656 /
 DATA (WAC(9,J) ,J=1,8 )/
C139.82 ,139.81 ,139.80 ,139.79 ,139.78 ,139.50 ,139.30 ,
C139.00 /
 DATA (ETA(9,J) ,J=1,8 )/
C0.4764 ,0.6011 ,0.7250 ,0.7774 ,0.7826 ,0.7774 ,0.7250 ,
C0.6992 /
 DATA (PR(10,J) ,J=1,8 )/
C1.0000 ,3.7650 ,6.4810 ,9.1760 ,10.219 ,11.479,12.711  ,
C14.412 /
 DATA (WAC(10,J),J=1,8 )/
C146.24 ,146.23 ,146.22 ,146.21 ,146.20 ,146.19 ,146.18 ,
C146.17 /
 DATA (ETA(10,J),J=1,8 )/
C0.4661 ,0.5702 ,0.6424 ,0.7250 ,0.7508 ,0.7508 ,0.7250 ,
C0.6424 /
 END
```

```
      BLOCK DATA LTURB
C     THIS IS A GENERALIZED L.P. TURBINE MAP
      COMMON/ LTURB/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/11,9*15,12,9,4*0/
      DATA TFF/ 88.470, 102.80, 116.84, 129.33, 141.05, 145.73, 150.00,
     1  153.35, 156.41, 159.78, 163.17,   4*0./
      DATA ( CN( 1,J),J=1,15)/
     C0.3682, 0.5336, 0.7365, 0.9754, 1.2146, 1.4173, 1.6201, 1.7673,
     C2.0247, 2.2827, 2.4665, 2.6137, 2.8166, 2.9456, 3.3138/
      DATA ( DH( 1,J),J=1,15)/
     C0.0010, 0.0026, 0.0035, 0.0044, 0.0051, 0.0056, 0.0059, 0.0061,
     C0.0062, 0.0061, 0.0057, 0.0053, 0.0044, 0.0035, 0.0001/
      DATA (ETA( 1,J),J=1,15)/
     C0.7120, 0.7300, 0.7472, 0.7300, 0.7140, 0.7008, 0.6850, 0.6730,
     C0.6452, 0.6200, 0.6000, 0.5750, 0.5310, 0.5000, 0.3850/
      DATA ( CN( 2,J),J=1,15)/
     C0.3682, 0.5518, 0.7919, 1 0672, 1.2882, 1.4446, 1.6937, 1.8954,
     C2.0619, 2.2273, 2.3747, 2.6229, 2.8720, 3.0555, 3.3138/
      DATA ( DH( 2,J),J=1,15)/
     C0.0026, 0.0039, 0.0054, 0.0069, 0.0080, 0.0087, 0.0096, 0.0101,
     C0.0104, 0.0107, 0.0108, 0.0106, 0.0101, 0.0094, 0.0077/
      DATA (ETA( 2,J),J=1,15)/
     C0.8000, 0.8100, 0.8200, 0.8300, 0.8300, 0.8290, 0.8100, 0.8000,
     C0.7850, 0.7600, 0.7450, 0.7000, 0.6800, 0.6450, 0.5900/
      DATA ( CN( 3,J),J=1,15)/
     C0.3682, 0.5911, 0.8655, 1.0764, 1.2519, 1.4354, 1.6201, 1.8409,
     C2.0247, 2.2455, 2.4302, 2.5956, 2.7791, 3.0555, 3.3138/
      DATA ( DH( 3,J),J=1,15)/
     C0.0031, 0.0051, 0.0071, 0.0087, 0.0099, 0.0111, 0.0122, 0.0134,
     C0.0143, 0.0152, 0.0157, 0.0162, 0.0166, 0.0167, 0.0164/
      DATA (ETA( 3,J),J=1,15)/
     C0.8800, 0.8300, 0.8600, 0.8630, 0.8670, 0.8700, 0.8720, 0.8720,
     C0.8700, 0.8670, 0.8600, 0.8500, 0.8300, 0.8000, 0.7600/
      DATA ( CN( 4,J),J=1,15)/
     C0.3682, 0.4237, 0.6810, 0.8837, 1.1047, 1.2882, 1.5090, 1.7482,
     C2.0429, 2.2091, 2.3747, 2.6047, 2.8720, 3.1291, 3.3138/
      DATA ( DH( 4,J),J=1,15)/
     C0.0033, 0.0038, 0.0061, 0.0078, 0.0096, 0.0110, 0.0126, 0.0141,
     C0.0159, 0.0166, 0.0174, 0.0183, 0.0191, 0.0195, 0.0197/
      DATA (ETA( 4,J),J=1,15)/
     C0.7995, 0.8000, 0.8400, 0.8600, 0.8680, 0.8730, 0.8800, 0.8830,
     C0.8839, 0.8830, 0.8800, 0.8740, 0.8600, 0.8350, 0.8200/
      DATA ( CN( 5,J),J=1,15)/
     C0.3682, 0.5065, 0.7365, 0.9754, 1.2882, 1.5647, 1.7301, 1.9690,
     C2.0983, 2.2637, 2.4332, 2.6691, 2.9456, 3.1846, 3.3138/
      DATA ( DH( 5,J),J=1,15)/
     C0.0036, 0.0049, 0.0071, 0.0092, 0.0119, 0.0141, 0.0155, 0.0172,
     C0.0181, 0.0192, 0.0202, 0.0214, 0.0226, 0.0235, 0.0239/
      DATA (ETA( 5,J),J=1,15)/
     C0.7750, 0.8000, 0.8480, 0.8600, 0.8750, 0.8900, 0.8912, 0.8940,
     C0.8955, 0.8970, 0.8961, 0.8900, 0.8790, 0.8671, 0.8600/
      DATA ( CN( 6,J),J=1,15)/
     C0.3682, 0.6164, 0.8372, 1.1047, 1.2882, 1.5283, 1.7482, 1.9509,
     C2.2133, 2.4302, 2.6510, 2.8619, 3.1384, 3.2584, 3.3138/
      DATA ( DH( 6,J),J=1,15)/
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C0.0038, 0.0064, 0.0087, 0.0113, 0.0130, 0.0152, 0.0171, 0.0187,
C0.0209, 0.0226, 0.0244, 0.0259, 0.0286, 0.0303, 0.0319/
 DATA (ETA( 6,J),J=1,15)/
C0.7600, 0.8000, 0.8450, 0.8600, 0.8730, 0.8900, 0.8950, 0.9000,
C0.9005, 0.9010, 0.9004, 0.9000, 0.8900, 0.8800, 0.8735/
 DATA ( CN( 7,J),J=1,15)/
C0.3682, 0.7728, 1.0129, 1.2659, 1.4729, 1.6785, 1.8409, 2.0247,
C2.1901, 2.3000, 2.3929, 2.5038, 2.5583, 2.6137, 2.6319/
 DATA ( DH( 7,J),J=1,15)/
C0.0044, 0.0089, 0.0115, 0.0141, 0.0162, 0.0181, 0.0197, 0.0216,
C0.0235, 0.0250, 0.0265, 0.0284, 0.0296, 0.0314, 0.0329/
 DATA (ETA( 7,J),J=1,15)/
C0.7310, 0.8000, 0.8300, 0.8600, 0.8750, 0.8900, 0.8930, 0.8975,
C0.8999, 0.9000, 0.8980, 0.8937, 0.8900, 0.8799, 0.8710/
 DATA ( CN( 8,J),J=1,15)/
C0.3682, 0.6072, 0.7919, 0.9754, 1.2337, 1.4548, 1.6383, 1.8409,
C1.9509, 2.0801, 2.1537, 2.2091, 2.2637, 2.3009, 2.3051/
 DATA ( DH( 8,J),J=1,15)/
C0.0048, 0.0078, 0.0102, 0.0124, 0.0153, 0.0177, 0.0201, 0.0226,
C0.0242, 0.0261, 0.0274, 0.0285, 0.0299, 0.0314, 0.0321/
 DATA (ETA( 8,J),J=1,15)/
C0.7100, 0.7450, 0.7680, 0.8000, 0.8380, 0.8600, 0.8712, 0.8780,
C0.8800, 0.8775, 0.8760, 0.8722, 0.8660, 0.8600, 0.8480/
 DATA ( CN( 9,J),J=1,15)/
C0.3682, 0.5518, 0.6629, 0.8282, 1.0129, 1.1691, 1.2337, 1.3809,
C1.5283, 1.6201, 1.7482, 1.8409, 1.8954, 1.9147, 1.9237/
 DATA ( DH( 9,J),J=1,15)/
C0.0054, 0.0080, 0.0096, 0.0119, 0.0141, 0.0160, 0.0169, 0.0188,
C0.0209, 0.0223, 0.0244, 0.0263, 0.0279, 0.0289, 0.0303/
 DATA (ETA( 9,J),J=1,15)/
C0.6780, 0.7000, 0.7125, 0.7350, 0.7690, 0.8000, 0.8060, 0.8225,
C0.8395, 0.8450, 0.8470, 0.8445, 0.8330, 0.8235, 0.8080/
 DATA ( CN(10,J),J=1,12)/
C0.3682, 0.4782, 0.6447, 0.7546, 0.8655, 0.9754, 1.1047, 1.2015,
C1.2701, 1.3073, 1.3365, 1.3407/
 DATA ( DH(10,J),J=1,12)/
C0.0061, 0.0078, 0.0104, 0.0122, 0.0139, 0.0157, 0.0181, 0.0201,
C0.0217, 0.0230, 0.0244, 0.0251/
 DATA (ETA(10,J),J=1,12)/
C0.6380, 0.6550, 0.6700, 0.6850, 0.7000, 0.7110, 0.7180, 0.7180,
C0.7170, 0.7140, 0.7000, 0.6890/
 DATA ( CN(11,J),J=1,9 )/
C0.3682, 0.4418, 0.5518, 0.6447, 0.7365, 0.8282, 0.8837, 0.9391,
C0.9715/
 DATA ( DH(11,J),J=1,9 )/
C0.0069, 0.0086, 0.0106, 0.0123, 0.0141, 0.0159, 0.0172, 0.0186,
C0.0201/
 DATA (ETA(11,J),J=1,9 )/
C0.6000, 0.6000, 0.6120, 0.6170, 0.6210, 0.6258, 0.6250, 0.6230,
C0.6009/
 END
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      BLOCK DATA ITURB
C     THIS IS A GENERALIZED I.P. TURBINE MAP
      COMMON/ ITURE/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/11,9*15,12,9,4*0/
      DATA TFF/ 39.670, 82.236, 93.468, 103.464, 112.836, 116.580,
     1 120.000, 122.68, 125.12, 127.82, 130.536,    4*0./
      DATA ( CN( 1,J),J=1,15)/
     C0.3522, 0.5104, 0.7044, 0.9330, 1.1618, 1.3556, 1.5497, 1.6905,
     C1.9367, 2.1835, 2.3593, 2.5001, 2.6941, 2.8175, 3.1698/
      DATA ( DH( 1,J),J=1,15)/
     C0.0016, 0.0023, 0.0031, 0.0038, 0.0045, 0.0049, 0.0052, 0.0054,
     C0.0055, 0.0054, 0.0051, 0.0047, 0.0038, 0.0031, 0.0001/
      DATA (ETA( 1,J),J=1,15)/
     C0.7120, 0.7300, 0.7472, 0.7300, 0.7140, 0.7000, 0.6850, 0.6730,
     C0.6452, 0.6200, 0.6000, 0.5750, 0.5310, 0.5000, 0.3850/
      DATA ( CN( 2,J),J=1,15)/
     C0.3522, 0.5278, 0.7575, 1.0208, 1.2322, 1.3818, 1.6201, 1.8130,
     C1.9723, 2.1305, 2.2715, 2.5089, 2.7471, 2.9227, 3.1698/
      DATA ( DH( 2,J),J=1,15)/
     C0.0023, 0.0035, 0.0047, 0.0061, 0.0070, 0.0076, 0.0084, 0.0089,
     C0.0092, 0.0094, 0.0095, 0.0093, 0.0089, 0.0083, 0.0068/
      DATA (ETA( 2,J),J=1,15)/
     C0.8000, 0.8100, 0.8200, 0.8300, 0.8300, 0.8290, 0.8100, 0.8000,
     C0.7830, 0.7600, 0.7450, 0.7000, 0.6800, 0.6450, 0.5900/
      DATA ( CN( 2,J),J=1,15)/
     C0.3522, 0.5654, 0.8279, 1.0296, 1.1975, 1.3730, 1.5497, 1.7609,
     C1.9367, 2.1479, 2.3245, 2.4827, 2.6583, 2.9227, 3.1698/
      DATA ( DH( 2,J),J=1,15)/
     C0.0027, 0.0045, 0.0063, 0.0076, 0.0087, 0.0098, 0.0107, 0.0118,
     C0.0126, 0.0134, 0.0139, 0.0142, 0.0146, 0.0147, 0.0145/
      DATA (ETA( 2,J),J=1,15)/
     C0.8000, 0.8300, 0.8600, 0.8630, 0.8670, 0.8700, 0.8720, 0.8720,
     C0.8700, 0.8670, 0.8600, 0.8500, 0.8300, 0.8000, 0.7600/
      DATA ( CN( 3,J),J=1,15)/
     C0.3522, 0.5654, 0.8279, 1.0296, 1.1975, 1.3730, 1.5497, 1.7609,
     C1.9367, 2.1479, 2.3245, 2.4827, 2.6583, 2.9227, 3.1698/
      DATA ( DH( 3,J),J=1,15)/
     C0.0027, 0.0045, 0.0063, 0.0076, 0.0087, 0.0098, 0.0107, 0.0118,
     C0.0126, 0.0134, 0.0139, 0.0142, 0.0146, 0.0147, 0.0145/
      DATA (ETA( 3,J),J=1,15)/
     C0.8000, 0.8300, 0.8600, 0.8630, 0.8670, 0.8700, 0.8720, 0.8720,
     C0.8700, 0.8670, 0.8600, 0.8500, 0.8300, 0.8000, 0.7600/
      DATA ( CN( 4,J),J=1,15)/
     C0.3522, 0.4052, 0.6514, 0.8452, 1.0567, 1.2322, 1.4434, 1.6722,
     C1.9540, 2.1131, 2.2715, 2.4915, 2.7471, 2.9931, 3.1698/
      DATA ( DH( 4,J),J=1,15)/
     C0.0029, 0.0034, 0.0054, 0.0069, 0.0084, 0.0097, 0.0111, 0.0124,
     C0.0140, 0.0146, 0.0153, 0.0161, 0.0168, 0.0172, 0.0173/
      DATA (ETA( 4,J),J=1,15)/
     C0.7995, 0.8000, 0.8400, 0.8600, 0.8680, 0.8730, 0.8800, 0.8830,
     C0.8835, 0.8830, 0.8800, 0.8740, 0.8600, 0.8350, 0.8200/
      DATA ( CN( 5,J),J=1,15)/
     C0.3522, 0.4844, 0.7044, 0.9330, 1.2322, 1.4967, 1.6548, 1.8834,
     C2.0071, 2.1652, 2.3274, 2.5531, 2.8175, 3.0461, 3.1698/
      DATA ( DH( 5,J),J=1,15)/
```

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C0.0031, 0.0043, 0.0062, 0.0081, 0.0105, 0.0124, 0.0136, 0.0152,
C0.0159, 0.0169, 0.0178, 0.0189, 0.0199, 0.0207, 0.0210/
 DATA (ETA( 5,J),J=1,15)/
C0.7750, 0.8000, 0.8480, 0.8600, 0.8750, 0.8900, 0.8912, 0.8940,
C0.8955, 0.8970, 0.8961, 0.8900, 0.8790, 0.8671, 0.8600/
 DATA ( CN( 6,J),J=1,15)/
C0.3522, 0.5896, 0.8008, 1.0567, 1.2322, 1.4619, 1.6722, 1.8660,
C2.1171, 2.3245, 2.5357, 2.7375, 3.0019, 3.1167, 3.1698/
 DATA ( DH( 6,J),J=1,15)/
C0.0034, 0.0057, 0.0076, 0.0100, 0.0114, 0.0134, 0.0150, 0.0165,
C0.0184, 0.0199, 0.0214, 0.0228, 0.0251, 0.0267, 0.0290/
 DATA (ETA( 6,J),J=1,15)/
C0.7600, 0.8000, 0.[illegible]50, 0.8600, 0.8730, 0.8900, 0.8950, 0.9000,
C0.9005, 0.9010, 0.9004, 0.9000, 0.8900, 0.8800, 0.8710/
 DATA ( CN( 7,J),J=1,15)/
C0.3522, 0.7392, 0.9689, 1.2109, 1.4089, 1.6056, 1.7609, 1.9367,
C2.0948, 2.2000, 2.2889, 2.3949, 2.4471, 2.5001, 2.5175/
 DATA ( DH( 7,J),J=1,15)/
C0.0038, 0.0078, 0.0101, 0.0124, 0.0142, 0.0159, 0.0173, 0.0190,
C0.0207, 0.0220, 0.0233, 0.0250, 0.0261, 0.0276, 0.0290/
 DATA (ETA( 7,J),J=1,15)/
C0.7310, 0.8000, 0.8300, 0.8600, 0.8750, 0.8900, 0.8930, 0.8975,
C0.8999, 0.9000, 0.8980, 0.8937, 0.8900, 0.8799, 0.8710/
 DATA ( CN( 8,J),J=1,15)/
C0.3522, 0.5808, 0.7575, 0.9330, 1.1801, 1.3915, 1.5671, 1.7609,
C1.8660, 1.9897, 2.0601, 2.1131, 2.1652, 2.2009, 2.2048/
 DATA ( DH( 8,J),J=1,15)/
C0.0042, 0.0069, 0.0090, 0.0109, 0.0135, 0.0156, 0.0177, 0.0199,
C0.0213, 0.0230, 0.0241, 0.0251, 0.0263, 0.0276, 0.0283/
 DATA (ETA( 8,J),J=1,15)/
C0.7100, 0.7450, 0.7680, 0.8000, 0.8380, 0.8600, 0.8712, 0.8780,
C0.8800, 0.8775, 0.8760, 0.8722, 0.8660, 0.8600, 0.8480/
 DATA ( CN( 9,J),J=1,15)/
C0.3522, 0.5278, 0.6340, 0.7922, 0.9689, 1.1183, 1.1801, 1.3209,
C1.4619, 1.5497, 1.6722, 1.7609, 1.8130, 1.8315, 1.8401/
 DATA ( DH( 9,J),J=1,15)/
C0.0047, 0.0070, 0.0084, 0.0104, 0.0124, 0.0141, 0.0148, 0.0166,
C0.0184, 0.0196, 0.0214, 0.0232, 0.0245, 0.0255, 0.0267/
 DATA (ETA( 9,J),J=1,15)/
C0.6780, 0.7000, 0.7125, 0.7350, 0.7690, 0.8000, 0.8060, 0.8225,
C0.8395, 0.8450, 0.8470, 0.8445, 0.8330, 0.8235, 0.8080/
 DATA ( CN(10,J),J=1,12)/
C0.3522, 0.4574, 0.6167, 0.7218, 0.8279, 0.9330, 1.0567, 1.1493,
C1.2148, 1.2505, 1.2784, 1.2824/
 CATA ( DH(10,J),J=1,12)/
C0.0054, 0.0069, 0.0092, 0.0107, 0.0123, 0.0138, 0.0159, 0.0177,
C0.0191, 0.0202, 0.0214, 0.0221/
 CATA (ETA(10,J),J=1,12)/
C0.6380, 0.6550, 0.6700, 0.6850, 0.7000, 0.7110, 0.7180, 0.7180,
C0.7170, 0.7140, 0.7000, 0.6890/
 DATA ( CN(11,J),J=1,9 )/
C0.3522, 0.4226, 0.5278, 0.6167, 0.7046, 0.7922, 0.8492, 0.8983,
C0.9293/
 DATA ( DH(11,J),J=1,9 )/
C0.0061, 0.0075, 0.0093, 0.0108, 0.0124, 0.0140, 0.0151, 0.0164,
C0.0177/
 DATA (ETA(11,J),J=1,9 )/
C0.6000, 0.6000, 0.6120, 0.6170, 0.6210, 0.6258, 0.6250, 0.6230,
C0.6009/
 END
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```
      BLOCK DATA HTURB
C     THIS IS A GENERALIZED H.P. TURBINE MAP
      COMMON / HTURB/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/10,9*15,12,5*0/
      DATA TFF/ 39.670, 42.990, 47.460, 48.610, 49.175, 49.600,
     1  50.000, 50.425, 50.920, 51.575,   5*0./
      DATA ( CN( 1,J),J=1,15)/
     C0.1872, 0.3372, 0.5156, 0.7128, 0.9382, 1.1442, 1.3138, 1.5382,
     C1.7264, 1.9324, 2.1500, 2.4058, 2.5892, 2.7862, 2.9460/
      DATA ( DH( 1,J),J=1,15)/
     C0.0032, 0.0057, 0.0084, 0.0108, 0.0133, 0.0152, 0.0164, 0.0174,
     C0.0179, 0.0176, 0.0167, 0.0144, 0.0120, 0.0082, 0.0034/
      DATA (ETA( 1,J),J=1,15)/
     C0.6219, 0.7078, 0.7868, 0.8090, 0.8090, 0.7963, 0.7779, 0.7422,
     C0.7078, 0.7635, 0.6068, 0.5309, 0.4773, 0.4045, 0.3034/
      DATA ( CN( 2,J),J=1,15)/
     C0.1872, 0.3942, 0.5814, 0.7128, 0.8442, 0.9804, 1.1068, 1.2754,
     C1.4450, 1.7068, 1.9696, 2.2706, 2.6970, 3.0960, 3.3774/
      DATA ( DH( 2,J),J=1,15)/
     C0.0036, 0.0080, 0.0113, 0.0136, 0.0156, 0.01[illegible], 0.0192, 0.0212,
     C0.0228, 0.0248, 0.0260, 0.0261, 0.0241, 0.0188, 0.0128/
      DATA (ETA( 2,J),J=1,15)/
     C0.6068, 0.7078, 0.8090, 0.8292, 0.8363, 0.8393, 0.8368, 0.8302,
     C0.8254, 0.8090, 0.7695, 0.7078, 0.6066, 0.5056, 0.4197/
      DATA ( CN( 3,J),J=1,15)/
     C0.1872, 0.4362, 0.6568, 0.8726, 1.0696, 1.2382, 1.4638, 1.6882,
     C1.9696, 2.2138, 2.5520, 2.8050, 3.0392, 3.2548, 3.3774/
      DATA ( DH( 3,J),J=1,15)/
     C0.0046, 0.0100, 0.0144, 0.0184, 0.0216, 0.0240, 0.0268, 0.0292,
     C0.0316, 0.0331, 0.0344, 0.0346, 0.0340, 0.0324, 0.0312/
      DATA (ETA( 3,J),J=1,15)/
     C0.5764, 0.7078, 0.8090, 0.8494, 0.8543, 0.8519, 0.8494, 0.8409,
     C0.8262, 0.8090, 0.7579, 0.7078, 0.6652, 0.6068, 0.5865/
      DATA ( CN( 4,J),J=1,15)/
     C0.1872, 0.2550, 0.4784, 0.6942, 0.9148, 1.1442, 1.3862, 1.5618,
     C1.8010, 1.9794, 2.2794, 2.5138, 2.8334, 3.1422, 3.3774/
      DATA ( DH( 4,J),J=1,15)/
     C0.0052, 0.0068, 0.0120, 0.0164, 0.0204, 0.0244, 0.0280, 0.0304,
     C0.0336, 0.0356, 0.0388, 0.0412, 0.0441, 0.0472, 0.0494/
      DATA (ETA( 4,J),J=1,15)/
     C0.5643, 0.6068, 0.7078, 0.8090, 0.8494, 0.8596, 0.8596, 0.8575,
     C0.8535, 0.9494, 0.8363, 0.8262, 0.8090, 0.7797, 0.7584/
      DATA ( CN( 5,J),J=1,15)/
     C0.1872, 0.3000, 0.5254, 0.7500, 0.9754, 1.2754, 1.4824, 1.7638,
     C2.0450, 2.3362, 2.6450, 2.8706, 3.0764, 3.1520, 3.1618/
      DATA ( DH( 5,J),J=1,15)/
     C0.0056, 0.0088, 0.0144, 0.0192, 0.0236, 0.0288, 0.0321, 0.0360,
     C0.0400, 0.0444, 0.0496, 0.0540, 0.0596, 0.0640, 0.0661/
      DATA (ETA( 5,J),J=1,15)/
     C0.5562, 0.6068, 0.7078, 0.8090, 0.8494, 0.8697, 0.8696, 0.8662,
     C0.8615, 0.8555, 0.8520, 0.8494, 0.8494, 0.8532, 0.8570/
      DATA ( CN( 6,J),J=1,15)/
     C0.1872, 0.3568, 0.6196, 0.8628, 1.0932, 1.2852, 1.5010, 1.6882,
     C1.9138, 2.1246, 2.2706, 2.4226, 2.4959, 2.5372, 2.5558/
      DATA ( DH( 6,J),J=1,15)/
```

```
C0.0068, 0.0120, 0.0192, 0.0252, 0.0300, 0.0340, 0.0384, 0.0421,
C0.0472, 0.0524, 0.0564, 0.0668, 0.0640, 0.0668, 0.0698/
 CATA (ETA( 6,J),J=1,15)/
C0.5309, 0.6068, 0.7078, 0.8090, 0.8494, 0.8697, 0.8819, 0.8899,
C0.8940, 0.8969, 0.8975, 0.8937, 0.8968, 0.8937, 0.8896/
 DATA ( CN( 7,J),J=1,15)/
C0.1872, 0.4314, 0.6844, 0.9568, 1.2010, 1.3834, 1.5108, 1.6186,
C1.7450, 1.8618, 1.9558, 2.0000, 2.0450, 2.0824, 2.1010/
 DATA ( DH( 7,J),J=1,15)/
C0.0080, 0.0164, 0.0236, 0.0308, 0.0372, 0.0416, 0.0448, 0.0476,
C0.0510, 0.0544, 0.0576, 0.0600, 0.0624, 0.0660, 0.0700/
 DATA (ETA( 7,J),J=1,15)/
C0.5062, 0.6068, 0.7078, 0.8090, 0.8494, 0.8697, 0.8797, 0.8899,
C0.8954, 0.9000, 0.9010, 0.9000, 0.8980, 0.8925, 0.8793/
 DATA ( CN( 8,J),J=1,15)/
C0.1872, 0.4834, 0.7314, 0.8814, 1.0226, 1.1442, 1.2804, 1.3696,
C1.4638, 1.5950, 1.6746, 1.7450, 1.8010, 1.8156, 1.8196/
 CATA ( DH( 8,J),J=1,15)/
C0.0088, 0.0196, 0.0272, 0.0316, 0.0356, 0.0392, 0.0432, 0.0460,
C0.0488, 0.0528, 0.0560, 0.0596, 0.0640, 0.0664, 0.0693/
 DATA (ETA( 8,J),J=1,15)/
C0.5051, 0.6068, 0.7078, 0.7665, 0.8090, 0.8292, 0.8494, 0.8596,
C0.8697, 0.8808, 0.8848, 0.8846, 0.8788, 0.8697, 0.8590/
 DATA ( CN( 9,J),J=1,15)/
C0.1872, 0.3372, 0.5344, 0.6754, 0.8068, 0.9196, 1.0128, 1.1254,
C1.2196, 1.3138, 1.3696, 1.4068, 1.4450, 1.4638, 1.4676/
 DATA ( DH( 9,J),J=1,15)/
C0.0093, 0.0159, 0.0232, 0.0284, 0.0330, 0.0368, 0.0400, 0.0442,
C0.0480, 0.0524, 0.0556, 0.0580, 0.0612, 0.0640, 0.0668/
 CATA (ETA( 9,J),J=1,15)/
C0.4909, 0.5380, 0.6068, 0.6573, 0.7078, 0.7463, 0.7776, 0.8090,
C0.8191, 0.8302, 0.8347, 0.8363, 0.8322, 0.8241, 0.8090/
 DATA ( CN(10,J),J=1,12)/
C0.1872, 0.2814, 0.3804, 0.4686, 0.5628, 0.6382, 0.6892, 0.7362,
C0.7696, 0.8068, 0.8254, 0.8304/
 CATA ( DH(10,J),J=1,12)/
C0.0132, 0.0180, 0.0228, 0.0268, 0.0314, 0.0352, 0.0380, 0.0412,
C0.0440, 0.0476, 0.0504, 0.0530/
 DATA (ETA(10,J),J=1,12)/
C0.4257, 0.4747, 0.5056, 0.5359, 0.5683, 0.5941, 0.6068, 0.6178,
C0.6240, 0.6310, 0.6265, 0.6118/
 END
```

SECTION VIII

SAMPLE INPUT LISTING

The first section of data cards is the set of variables selected for output (controlled output). The second section is the Namelist input for running the desired points. The Namelist input consists of the following points: design point at sea-level static, a setup case for sea-level static afterburning, a sea-level static full afterburning point, several points in a subsonic power hook, a setup case for supersonic afterburning, and the supersonic full afterburning point.

```
T55
P55
T24
P24
WAC
WFB
WG24
FAR24
T25
P25
DPDUC
ETAC
AM25
AM55
ETAF
ETAI
ETAC
ETATHC
ETATIF
ETATLC
T6
P6
PS6
AM6
V6
WG6
T7
WFA
FAR7
ETAA
DRAFT
PS8
AM8
V8
PS9
AM9
V9
PS28
AM28
V28
PS29
AM29
V29
BYPASS
HPEXT
WFT
WGT
VA
FRD
CVMNOZ
VJM
CVPNOZ
VJP
FGM
FGP
```

```
A55
A25
A6
A8
A9
A28
A29
THEEND
 $DATAIN ITITLE=1,IDES=1,IDUMP=1,IAMTP=0,MODE=3,
 IGASMX=2,TMOD=1,PS55=2.0,AM55=0.00,AM6=0.24,HPEXT=0.,NOZFLT=0,
 ITRYS=200.,TOLALL=.005,ZFDS=0.8333,ZIDS=0.8143,ZCDS=0.8143,
 PCNFDS=100.,ETAFDS=0.839,PCNIDS=100.,ETAIDS=0.853,PCNCDS=100.,
 ETACDS=0.853,DPCODS=0.047,DPDUDS=0.05,DTCODS=1250.,ETABDS=0.9875,
 PRFDS=2.2,PRIDS=3.435,PRCDS=7.435,WAFDS=354.,WAIDS=108.,
 TFHPDS=50.0,CNHPDS=2.0,ETHPDS=0.881,TFIPDS=120.,CNIPDS=2.2,ETIPDS=.881,
 TFLPDS=130.0,CNLPDS=2.3,ETLPDS=0.917,DPAFDS=0.0,CVMNOZ=0.989,
 DELFG=1.0,DELFN=1.0,DELSFC=1.0,PCBLF=0.0,PCBLI=0.0,PCBLC=0.0,
 T4DS=2860.,AM=0.0,ALTP=0.0$
      SLS TRISPL DESIGN POINT
 $DATAIN MODE=0,T4=2860.,ITITLE=1$
      SETUP FOR SLS AFTERBURNING
 $DATAIN T4=2860.,IAFTBN=1,T7=3700.,ETAA=0.875,ITITLE=1$
      SLS FULL AFTERBURNING
 $DATAIN MODE=3,PCNF=99.0,AM=0.75,ALTP=25000.,ITITLE=1$
      SUBSONIC POWER HOOK
 $DATAIN PCNF=90.$
 $DATAIN PCNF=80.$
 $DATAIN PCNF=70.$
 $DATAIN MODE=1,PCNC=100.,AM=1.8,ALTP=50000.,ITITLE=1$
      SETUP FOR SUPERSONIC AFTERBURNING
 $DATAIN PCNC=100.,IAFTBN=1,T7=3700.,ETAA=0.85,ITITLE=1$
      SUPERSONIC FULL AFTERBURNING
 $DATAIN IEND=1$
```

SECTION IX

SAMPLE OUTPUT LISTING

The following are typical computer printouts, the first point is the design point and includes a page of correction (or scaling) factors and a page of values of variables in common. The other operating points consist of a page of output for each point. Not included for these points is a common dump, which follows each output page and is very similar to the common dump following the design point correction factors.

```
                                        [illegible] POINT
FAN DESIGN              PRFCF=  .30001200E+01 ETAFCF=  .95341519E+00  HAFCF=  .58999571E+0J   T2DS=  .51866820E+03
I.P. COMPRESSOR DESIGN  FRICF=  .41531922E+01 ETAICF=  .97287007E+00  WAICF=  .18585113E+00  T21DS=  .67476966E+03
H.P. COMPRESSOR DESIGN  PRCCF=  .34787092E+00 ETACCF=  .99186872E+00  WACCF=  .19857858E+00  T22DS=  .10024498E+04
COMBUSTOR DESIGN       WA3CDS=  .10833805E+02 ETABCF=  .98750000E+00 CTCOCF=  .89568386E+00
H.P. TURBINE DESIGN    CNHPCF=  .10695794E+01 TFHPCF=  .30748997E+01 ETHPCF=  .97888889E+00 DHHPCF=  .67280169E+00
I.P. TURBINE DESIGN    CNIPCF=  .10950379E+01 TFIPCF=  .38446973E+01 ETIPCF=  .97888889E+00 DHIPCF=  .14359988E+01
L.P. TURBINE DESIGN    CNLPCF=  .10820381E+01 TFLPCF=  .25251660E+01 ETLPCF=  .10394036E+01 DHLPCF=  .31564692E+01
DUCT DESIGN            WA23DS=  .29046259E+04
TURBINE/DUCT AREA DESIGN  A55=  .18400091E+01   AM55=  .65168846E+00    A25=  .64758021E+01   AM25=  .25239827E+00
AFTERBURNER ENTRANCE DESIGN AREA A6    11.620
AFTERBURNER DESIGN     WG6CDS=  .51899812E+04
NOZZLE DESIGN              A8=  .46147586E+01    AM8=  .10000080E+01     A9=  .46825091E+01    AM9=  .11367079E+01
MAIN SHOCK OUTSIDE C-D NOZZLE       FG= 17454.88                FN= 17454.88                SFC=  .52412
```

```
ONVERGED AFTER    1 LOOPS

MMON             .833300E+00   .100000E+03   .814300E+00   .100000E+03   .814300E+00   .100000E+03   .286000E+04   3

  .100000E+03   .100000E+03   .100000E+03   .286000E+04  0.             .100000E+01   .100000E+01   .100000E+01
  .833300E+00   .100000E+03   .220000E+01   .839000E+00   .354000E+03   .300012E+01   .953415E+00   .589996E+00
  .814300E+00   .100000E+03   .343500E+01   .853000E+00   .108000E+03   .415319E+01   .972870E+00   .185851E+00
  .814300E+00   .100000E+03   .343500E+01   .853000E+00   .108000E+03   .347871E+00   .991869E+00   .198679E+00
  .286000E+04  0.             .125000E+04   .987500E+00   .108338E+02   .470000E-01   .895684E+00   .987500E+00
  .500000E+02   .200000E+01   .881000E+00   .307490E+01   .106958E+01   .978889E+00   .672802E+00   .518668E+03
  .120000E+03   .220000E+01   .881000E+00   .384470E+01   .109504E+01   .978889E+00   .143600E+01   .674770E+03
  .130000E+03   .230000E+01   .917000E+00   .252517E+01   .108204E+01   .103940E+01   .315647E+01   .100245E+04
 0.            0.            0.            0.             .290463E+04   .500000E-01  0.            0.
 0.            0.            0.            0.             .518998E+04  0.            0.            0.
  .184001E+01   .647580E+01   .116201E+02   .116201E+02   .461476E+01   .468251E+01  0.            0.
  .200000E+01   .651698E+00  0.             .990000E+00  0.            0.            0.            0.

  .518670E+03   .100000E+01   .123918E+03   .159103E+01   .518668E+03   .100000E+01   .123918E+03   .159103E+01
  .674770E+03   .220000E+01   .161385E+03   .160010E+01   .100245E+04   .755700E+01   .241496E+03   .161215E+01
  .146442E+04   .259583E+02   .359665E+03   .162430E+01   .286000E+04   .247383E+02   .774590E+03   .182875E+01
  .247750E+04   .119953E+02   .659137E+03   .183511E+01   .221324E+04   .687363E+01   .580868E+03   .183992E+01
  .179758E+04   .262349E+01   .460883E+03   .184603E+01  0.            0.            0.            0.
  .100000E+01   .220000E+01   .839000E+00   .600004E+03   .354000E+03  0.            0.            0.
  .100000E+01   .343500E+01   .853000E+00   .301279E+03   .108000E+03  0.            0.             .108000E+03
  .100000E+01   .343500E+01   .853000E+00   .100000E+03   .108000E+03   .987500E+00   .470000E-01   .110541E+03
  .200000E+01   .881000E+00   .403681E-01   .115453E+03  0.            0.            0.             .235298E-01
  .220000E+01   .881000E+00   .315920E-01   .782690E+02  0.            0.            0.            0.
  .230000E+01   .917000E+00   .542121E-01   .119985E+03  0.            0.            0.             .111699E+04
  .110541E+03   .235298E-01   .110541E+03   .235298E-01   .110541E+03   .235298E-01  0.            0.
 0.             .100000E+01   .833300E+00   .100000E+03   .814300E+00   .100000E+03   .814300E+00   .100000E+03
  .254122E+01   .500000E+02   .120000E+03   .130300E+03  0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.            0.            0.
 0.

  .100000E+01   .354000E+03   .108000E+03   .108000E+03  0.            0.            0.            0.
  .241496E+03   .359665E+03   .674770E+03   .220000E+01   .161385E+03   .160810E+01  0.            0.
  .674770E+03   .220000E+01   .161385E+03   .160010E+01   .674770E+03   .209000E+01   .161385E+03   .160362E+01
  .674770E+03   .209000E+01   .161385E+03   .160362E+01  0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.            0.            0.
  .246000E+03  0.             .246000E+03  0.            0.             .500000E-01   .227778E+01  0.
 0.            0.            0.            0.            0.            0.            0.            0.

  .179758E+04   .262349E+01   .460883E+03   .184603E+01   .674770E+03   .209000E+01   .161385E+03   .160362E+01
  .254122E+01   .110541E+03   .235298E-01  0.             .246000E+03  0.             .100000E+01  0.
  .104745E+04   .222336E+01   .254240E+03   .170844E+01   .104745E+04   .222336E+01   .254240E+03   .170844E+01
  .104745E+04   .222336E+01   .254240E+03   .170844E+01   .104745E+04   .222336E+01   .254240E+03   .170844E+01
  .356541E+03  0.             .356541E+03   .717858E-02  0.            0.             .127516E+04   .319137E+03
  .213757E+01   .375176E+03   .240000E+00   .103628E+04   .213745E+01   .375176E+03   .240000E+00   .252398E+00
  .880181E+03   .118643E+01   .144567E+04   .100000E+01   .840629E+03   .100000E+01   .160726E+04   .113671E+01
 0.            0.            0.            0.             .157512E+04   .174549E+05  0.            0.
  .174549E+05  0.             .254122E+01   .356541E+03   .717858E-02   .174549E+05   .174549E+05   .524116E+00
```

```
                         SETUP FOR SLS AFTERBURNING

OUTPUT               AM=   0.000       ALTP=       0.          T4= 2860.00                       ETAR= 1.0000
                      PCNF          CNF           ZF            PRF           WAFC          WAF
                     .100000E+03   .100000E+01   .833300E+00   .220000E+01   .600004E+03   .354000E+03
                      PCNI          CNI           ZI            PRI           WAIC          WAI
                     .100000E+03   .100000E+01   .814300E+00   .343500E+01   .301279E+03   .108000E+03
                      PCNC          CNC           ZC            PRC           WACC          WAC
                     .100000E+03   .100000E+01   .814300E+00   .343500E+01   .100000E+03   .108000E+03
                      T2            P2            T21           P21           T22           P22
                     .518668E+03   .100000E+01   .674770E+03   .220000E+01   .100245E+04   .755700E+01
                      T3            P3            BLF           BLI           BLC           BLOU
                     .146442E+04   .259583E+02  0.            0.            0.            0.
                      BLOB          BLHP          OLIF          BLLP          T4            P4
                    0.            0.            0.            0.            .286000E+04   .247383E+02
                      WA3           WFB           WG4           FAR4          ETAB          DPCOM
                     .108000E+03   .254122E+01   .110541E+03   .235298E-01   .987500E+00   .470000E-01
                      TFFHP         CNHP          DHTCHP        DHTC          T45           P45
                     .500000E+02   .280080E+01   .403681E-01   .115453E+03   .247750E+04   .119953E+02
                      TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                     .128080E+03   .220080E+01   .315920E-01   .782698E+02   .221324E+04   .667363E+01
                      TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                     .130080E+03   .230000E+01   .542121E-01   .119985E+03   .179758E+04   .262349E+01
                      T24           P24           WAD           WFD           WG24          FAR24
                     .674770E+03   .289000E+01   .246008E+03  0.            .246008E+03  0.
                      T25           P25           DPDUC         ETAD          AM25          AM55
                     .674770E+03   .209080E+01   .500800E-01  0.            .252415E+00   .652110E+00
                      ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                     .839000E+00   .853000E+00   .853800E+00   .881000E+00   .881000E+00   .917000E+00
                      T6            P6            PS6           AM6           V6            WG6
                     .164745E+04   .222358E+01   .213765E+01   .239991E+00   .375160E+03   .356541E+03
                      T7            WFA           FAR7          ETAA          DPAFT         PS8
                     .164745E+04  0.            .717858E-02  0.            0.            .118643E+01
                      AM8           V8            FS9           AM9           V9            PS28
                     .100000E+01   .144567E+04   .100035E+01   .113624E+01   .160485E+04  0.
                      AM28          V28           PS29          AM29          V29           BYPASS
                    0.            0.            0.            0.            0.            .227778E+01
                      HPEXT         WFT           WGT           VA            FRD           CVMNO7
                    0.            .254122E+01   .356541E+03  0.            0.            .980000E+00
                      VJM           CVONOZ        VJC           FGM           FGP           A55
                     .157275E+04  0.            0.            .174286E+05   .346999E+01   .184001E+01
                      A25           A6            A8            A9            A28           A29
                     .647580E+01   .116201E+02   .461476E+01   .468251E+01  0.            0.

MAIN SHOCK OUTSIDE C-D NOZZLE          FG= 17432.11                  FN= 17432.11                SFC=  .524
```

```
                                   SLS FULL AFTERBURNING

NOZZLE DESIGN           A8=  .11178959E+02    AM8=  .10000000E+01     A9=  .1119071.E+02    AM9=  .10347625E+01

OUTPUT              AM=   0.000       ALTP=       0.            T4= 2860.00           T7= 3700.00         ETAR= 1.0000
                      PCNF          CNF            ZF             PRF              WAFC              WAF
                    .100000E+03   .100000E+01    .833300E+00    .220000E+01     .600004E+03      .354000E+03
                      PCNI          CNI            ZI             PRI              WAIC              WAI
                    .100000E+03   .100000E+01    .814300E+00    .343500E+01     .301279E+03      .108000E+03
                      PCNC          CNC            ZC             PRC              WACC              WAC
                    .100000E+03   .100000E+01    .814300E+00    .343506E+01     .100000E+03      .108000E+03
                      T2            P2             T21            P21              T22               P22
                    .518668E+03   .100000E+01    .674770E+03    .220000E+01     .100245E+04      .755700E+01
                      T3            P3             BLF            BLI              BLC               BLDU
                    .146442E+04   .259533E+02   0.             0.               0.                0.
                      BLD8          BLHP           BLIP           BLLP             T4                P4
                   0.            0.             0.             0.               .286000E+04      .247383E+02
                      WA3           WFB            WG4            FAR4             ETAB              DPCOM
                    .168005E+03   .254122E+01    .110541E+03    .235298E-01     .937500E+00      .470000E-01
                      TFFHP         CNHP           DHTCHP         DHTC             T45               P45
                    .500000E+02   .200000E+01    .403681E-01    .115453E+03     .247750E+04      .119953E+02
                      TFFIP         CNIP           DHTCIP         DHTI             T5                P5
                    .120000E+03   .220000E+01    .315920E-01    .782690E+02     .221324E+04      .687363E+01
                      TFFLP         CNLP           DHTCLP         DHTF             T55               P55
                    .130000E+03   .230000E+01    .542121E-01    .119985E+03     .179758E+04      .262349E+01
                      T24           P24            WAD            WFD              WG24              FAR24
                    .674770E+03   .209000E+01    .246000E+03   0.               .246000E+03      0.
                      T25           P25            DPDUC          ETAD             AM25              AM55
                    .674770E+03   .209000E+01    .500000E-01   0.               .252415E+00      .652110E+00
                      ETAF          ETAI           ETAC           ETATHP           ETATIP            ETATLP
                    .839000E+00   .853000E+00    .853000E+00    .881000E+00     .881000E+00      .917000E+00
                      T6            P6             PS6            AM6              V6                WG6
                    .104745E+04   .222358E+01    .213765E+01    .239991E+00     .375160E+03      .356541E+03
                      T7            SFA            FAR7           ETAA             DPAFT             PS8
                    .370000E+04   .183777E+02    .605055E-01    .875000E+00    0.                .104245E+01
                      AM8           V8             PS9            AM9              V9                PS28
                    .100000E+01   .256563E+04    .100000E+01    .103476E+01     .274746E+04      0.
                      AM28          V28            PS29           AM29             V29               BYPASS
                   0.            0.             0.             0.               0.                .227778E+01
                      HPEXT         WFT            WGT            VA               FRD               CVMNOZ
                   0.             .214189E+02    .375419E+03   0.               0.                .988000E+00
                      VJM           CVDNOZ         VJD            FGM              FGP               A55
                    .269252E+04  0.             0.              .314172E+05    0.                .184081E+01
                      A25           A8             AM             A9               A28               A29
                    .647530E+01   .112201E+02    .111750E+02    .111907E+02    0.                0.

MAIN SHOCK OUTSIDE C-D NOZZLE     FG= 31417.20                  FN= 31417.20                          SFC= 2.45433
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                         [illegible] POWER HOOK

OUTPUT              AM=    .750        ALTP= 25000.          T4= 2825.19                              ETAR= 1.0000
                      PCNF            CNF             ZF              PRF             WAFC            WAF
                     .990000E+02     .103121E+01     .868973E+00     .233598E+01     .622954E+03     .206372E+03
                      PCNI            CNI             ZI              PRI             WAIC            WAI
                     .997800E+02     .102371E+01     .917086E+00     .356883E+01     .312177E+03     .657156E+02
                      PCNC            CNC             ZC              PRC             WACC            WAC
                     .988020E+02     .100375E+01     .826046E+00     .348988E+01     .100651E+03     .656722E+02
                      T2              F2              T21             P21             T22             P22
                     .478044E+03     .539056E+00     .641051E+03     .125923E+01     .971275E+03     .449396E+01
                      T3              F3              BLF             BLI             BLC             BLDU
                     .142966E+04     .156834E+02    0.              0.              0.              0.
                      BLOB            SLHP            BLIP            BLLP            T4              P4
                    0.              0.              0.              0.               .282519E+04     .149504E+02
                      WA3             WFB             WG4             FAR4            ETAB            DPCOM
                     .656722E+02     .153855E+01     .672107E+02     .234278E-01     .987500E+00     .467386E-01
                      TFFHP           CNHP            DHTCHP          DHTC            T45             P45
                     .500210E+02     .198818E+01     .403839E-01     .114120E+03     .244641E+04     .724009E+01
                      TFFIP           CNIP            DHTCIP          DHTI            T5              P5
                     .120166E+03     .220905E+01     .321475E-01     .786993E+02     .218809E+04     .409828E+01
                      TFFLP           CNLP            DHTCLP          DHTF            T55             P55
                     .131393E+03     .229425E+01     .550116E-01     .119961E+03     .176320E+04     .154208E+01
                      T24             P24             WAD             WFD             WG24            FAR24
                     .641051E+03     .119792E+01     .140656E+03    0.               .140656E+03    0.
                      T25             P25             DPDUC           ETAD            AM25            AM55
                     .641051E+03     .119792E+01     .486833E-01    0.               .244784E+00     .682441E+00
                      ETAF            ETAI            ETAC            ETATHP          ETATIP          ETATLP
                     .805772E+00     .836766E+00     .849513E+00     .888207E+00     .879144E+00     .919003E+00
                      T6              P6              PS6             AM6             V6              WG6
                     .102871E+04     .128425E+01     .123459E+01     .239997E+00     .371929E+03     .207867E+03
                      T7              WFA             FAR7            ETAA            DPAFT           PS8
                     .102871E+04    0.               .745684E-02    0.              0.               .685188E+00
                      AM8             V8              PS9             AM9             V9              PS28
                     .100000E+01     .143283E+04     .577783E+00     .113625E+01     .159056E+04    0.
                      AM28            V28             PS29            AM29            V29             BYPASS
                    0.              0.              0.              0.              0.               .214037E+01
                      HPEXT           WFT             WGT             VA              FRD             CVMNOZ
                    0.               .153855E+01     .207510E+03     .762422E+03     .489035E+04     .980080E+00
                      VJM             CVONOZ          VJD             FGM             FGP             A55
                     .155875E+04    0.              0.               .100706E+05     .204814E+04     .184001E+01
                      A25             A6              A8              A9              A28             A29
                     .647580E+01     .116201E+02     .461476E+01     .468251E+01    0.              0.

MAIN SHOCK OUTSIDE C-D NOZZLE          FG= 12118.73                FN=  7228.39                     SFC=  .76626
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                                   SUBSONIC POWER HOOK

OUTPUT                  AM=    .750       ALTP= 25000.          T4= 2565.19                      ETAR= 1.0000
                          PCNF          CNF           ZF            PRF           WAFC          WAF
                        .900000E+02   .937461E+00   .782423E+00   .200929E+01   .562351E+03   .186295E+03
                          PCNI          CNI           ZI            PRI           WAIC          WAI
                        .915560E+02   .968273E+00   .821374E+00   .332627E+01   .289386E+03   .540067E+02
                          PCNC          CNC           ZC            FRC           WACC          WAC
                        .932758E+02   .991281E+00   .802111E+00   .335910E+01   .986808E+02   .539970E+02
                          T2            P2            T21           P21           T22           P22
                        .478044E+03   .539055E+00   .603440E+03   .166312E+01   .887578E+03   .360276E+01
                          T3            P3            BLF           BLI           BLC           BLDU
                        .129833E+04   .121020E+02  0.            0.            0.            0.
                          BLOB          BLHP          BLIF          BLLP          T4            P4
                       0.            0.            0.            0.            .250519E+04   .115277E+02
                          WA3           WFB           WG4           FAR4          ETAB          DPCOM
                        .539970E+02   .105868E+01   .550556E+02   .196062E-01   .987500E+00   .474593E-01
                          TFFHP         CNHP          DHTCHP        DHTC          T45           P45
                        .500143E+02   .199325E+01   .464243E-01   .101308E+03   .216052E+04   .556874E+01
                          TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                        .128217E+03   .215719E+01   .312377E-01   .675700E+02   .192572E+04   .320299E+01
                          TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                        .129702E+03   .221916E+01   .527765E-01   .101624E+03   .156240E+04   .125485E+01
                          T24           P24           WAD           WFD           WG24          FAR24
                        .603440E+03   .102718E+01   .132288E+03  0.            .132288E+03  0.
                          T25           P25           DPDUC         ETAD          AM25          AM55
                        .603440E+03   .102718E+01   .516465E-01  0.            .261722E+00   .614054E+00
                          ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                        .843004E+00   .860883E+00   .847832E+00   .880408E+00   .879322E+00   .910058E+00
                          T6            P6            PS6           AM6           V6            WG6
                        .941670E+03   .108301E+01   .104116E+01   .239334E+00   .348319E+03   .187344E+03
                          T7            WFA           FAR7          ETAA          CPAFT         PS8
                        .961683E+03  0.            .568310E-02  0.            0.            .575798E+00
                          AM8           V8            PS9           AM9           V9            PS28
                        .100000E+01   .134264E+04   .485782E+00   .113653E+01   .149032E+04  0.
                          AM7           V28           PS29          AM29          V29           BYPASS
                       0.            0.            0.            0.            0.            .244948E+01
                          HPEXT         WFT           WGT           VA            FRD           CVMNOZ
                       0.             .105868E+01   .187354E+03   .762422E+03   .441465E+04   .980800E+00
                          VJM           CVDNOZ        VJD           FGM           FGP           A55
                        .146851E+04  0.            0.            .850431E+04   .113648E+04   .184001E+01
                          A25           A6            A8            A9            A28           A29
                        .647550E+01   .116201E+02   .461476E+01   .468251E+01  0.            0.

MAIN SHOCK OUTSIDE C-D NOZZLE       FG=  9640.79            FN=  5226.20                 SFC=  .72926
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                    SUBSONIC POWER HOOK

OUTPUT          AM=    .750      ALTP= 25000.          T4= 2259.62                           ETAR= 1.0000
                 PCNF          CNF           ZF            PRF           WAFC          WAF
                .800000E+02   .833299E+00   .680838E+00   .172439E+01   .501279E+03   .166047E+03
                 PCNI          CNI           ZI            PRI           WAIC          WAI
                .834666E+02   .904295E+00   .229222E+00   .308410E+01   .265697E+03   .436001E+02
                 PCNC          CNC           ZC            PRC           WACC          WAC
                .884379E+02   .976350E+00   .780779E+00   .323059E+01   .963988E+02   .436025E+02
                 T2            P2            T21           P21           T22           P22
                .478044E+03   .539056E+00   .574658E+03   .929545E+00   .822485E+03   .286081E+01
                 T3            P3            BLF           BLI           BLC           BLDU
                .113656E+04   .926149E+01  0.            0.            0.            0.
                 BLOB          BLHP          BLIP          BLLP          T4            P4
               0.            0.            0.            0.            .225932E+04   .881625E+01
                 WA3           WFB           NG4           FAR4          ETAB          DPCOM
                .436025E+02   .733083E+00   .443355E+02   .160129E-01   .987500E+00   .480744E-01
                 TFFHP         CNHP          DHTCHP        DHTC          T45           P45
                .500249E+02   .198921E+01   .105279E-01   .916093E+02   .194121E+04   .424224E+01
                 TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                .120474E+03   .207446E+01   .302336E-01   .588174E+02   .173205E+04   .248012E+01
                 TFFLP         CNLP          DHTCLP        DHTP          T55           P55
                .327824E+03   .207995E+01   .500979E-01   .868027E+02   .141454E+04   .101980E+01
                 T24           P24           WAO           WFD           WG24          FAR24
                .574858E+03   .879009E+00   .122446E+03  0.            .122446E+03  0.
                 T25           P25           DPDLC         ETAD          AM25          AM55
                .574858E+03   .879009E+00   .543671E-01  0.            .277619E+00   .556009E+00
                 ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                .833962E+00   .875427E+00   .839205E+00   .879697E+00   .877473E+00   .916426E+00
                 T6            P6            PS6           AM6           V6            WG6
                .809179E+03   .912776E+00   .877458E+00   .238970E+00   .330137E+03   .166782E+03
                 T7            WFA           FAR7          ETAA          CPAFT         PS8
                .809179E+03  0.            .441486E-02  0.            0.            .484374E+00
                 AM8           V8            PS9           AM9           V9            PS28
                .100000E+01   .127256E+04   .409922E+00   .113661E+01   .141239E+04  0.
                 AM28          V28           PS29          AM29          V29           BYPASS
               0.            0.            0.            0.            0.            .200840E+01
                 HPEXT         WFT           WGT           VA            FRD           CVMNOZ
               0.            .733083E+00   .166780E+03   .762422E+03   .393477E+04   .980000E+00
                 VJM           CVDNOZ        VJD           FGM           FGP           A55
                .138415E+04  0.            0.            .717506E+04   .374860E+03   .184001E+01
                 A25           A6            A8            A9            A28           A29
                .647580E+01   .116201E+02   .461476E+01   .468251E+01  0.            0.

MAIN SHOCK OUTSIDE C-D NOZZLE          FG=  7549.92                 FN=  3615.14                    SFC=  .73001
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                           SUBSONIC POWER HOOK

OUTPUT              AM=    .750      ALTP= 25000.          T4= 1999.81                      ETAR= 1.0000
                      PCNF          CNF           ZF            PRF           WAFC          WAF
                     .700600E+02   .729137E+00   .534079E+00   .335839E+01   .441756E+03   .146345E+03
                      PCNI          CNI           ZI            PRI           WAIC          WAI
                     .725324E+02   .806767E+00   .808100E+00   .263448E+01   .231884E+03   .330381E+02
                      PCNC          CNC           ZC            PRC           WACC          WAC
                     .830559E+02   .962114E+00   .759621E+00   .318113E+01   .941981E+02   .330334E+02
                      T2            P2            T21           P21           T22           P22
                     .478044E+03   .539056E+00   .545438E+03   .786153E+00   .747252E+03   .211827E+01
                      T3            P3            BLF           BLI           BLC           BLDU
                     .108124E+04   .658600E+01  0.            0.            0.            0.
                      BLOB          BLHP          BLIP          BLLP          T4            P4
                    0.            0.            0.            0.            .199981E+04   .626534E+01
                      WA3           HFB           WG4           FAR4          ETAB          DPCOM
                     .330334E+02   .465903E+04   .334993E+02   .141040E-01   .986737E+00   .486867E-01
                      TFFHP         CNHP          DHTCHP        DHTC          T45           P45
                     .500338E+02   .198650E+01   .405910E-01   .811664E+02   .171031E+04   .300474E+01
                      TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                     .122625E+03   .192054E+01   .279649E-01   .478546E+02   .153555E+04   .182993E+01
                      TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                     .123273E+03   .193290E+01   .459584E-01   .704557E+02   .127145E+04   .812212E+00
                      T24           P24           WAD           WFD           WG24          FAR24
                     .545438E+03   .740601E+00   .113307E+03  0.            .113307E+03  0.
                      T25           P25           DPDUC         ETAD          AM25          AM55
                     .545438E+03   .740601E+00   .579432E-01  0.            .299048E+00   .475891E+00
                      ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                     .867344E+00   .883245E+00   .831202E+00   .879504E+00   .874379E+00   .911912E+00
                      T6            P6            PS6           AM6           V6            WG6
                     .717923E+03   .756935E+00   .727659E+00   .238473E+00   .310859E+03   .146806E+03
                      T7            WFA           FAR7          ETAA          DPAFT         PS8
                     .717923E+03  0.            .318369E-02  0.            0.            .400881E+00
                      AM8           V8            PS9           AM9           V9            PS28
                     .100000E+01   .119933E+04   .338145E+00   .113661E+01   .133091E+04  0.
                      AM28          V28           PS29          AM29          V29           BYPASS
                    0.            0.            0.            0.            0.            .342959E+01
                      HPEXT         WFT           WG1           VA            FRD           CVMNOZ
                    0.             .465903E+00   .146811E+03   .762422E+03   .346791E+04   .980000E+00
                      WJM           CVGNOZ        WJD           FGM           FGP           A55
                     .130429E+04  0.            0.            .595133E+04  -.326485E+03   .184801E+01
                      A25           A6            A8            A9            A28           A29
                     .647580E+01   .116201E+02   .461476E+01   .468251E+01  0.            0.

MAIN SHOCK OUTSIDE C-D NOZZLE     FG=  5624.55               FN=  2156.94                   SFC=  .77761
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                                  [illegible] AFTERBURNING

OUTPUT          AM=  1.800       ALTP= 50000.             T4= 2860.40                                FTAR=  .9445
                  PCNF             CNF             ZF               PRF             WAFC             WAF
                 .885781E+02     .795330E+00     .645432E+00     .163708E+01     .477553E+03     .157100E+03
                  PCNI             CNI             ZI               FRI             WAIC             WAI
                 .926054E+02     .872474E+00     -822453E+00     .295360E+01     .254618E+03     .397357E+02
                  PCNC             CNC             ZC               FRC             WACC             WAC
                 .100000E+03     .970105E+00     .772839E+00     .318068E+01     .554252E+02     .397237E+02
                  T2               P2              T21              P21             T22              P22
                 .643321E+03     .620975E+00     .760192E+03     .101658E+01     .106518E+04     .300258E+01
                  T3               P3              BLF              BLI             BLC              BLDU
                 .152572E+04     .955024E+01    0.               0.              0.               0.
                  BLOB             BLHP            BLIF             BLLP            T4               P4
                0.               0.              0.               0.               .286040E+04     .969220E+01
                  WA3              WFB             WG4              FAR4            ETAB             DPCOM
                 .397237E+02     .896199E+00     .406199E+02     .225608E-01     .987500E+00     .479613E-01
                  TFFHP            CNHP            DHTCHP           CHTC            T45              P45
                 .508898E+02     .199986E+01     .405698E-01     .116074E+03     .247514E+04     .436759E+01
                  TFFIP            CNIP            DHTCIP           DHTI            T5               P5
                 .120519E+03     .303829E+01     .296827E-01     .734843E+02     .222672E+04     .259858E+01
                  TFFLP            CNLP            DHTCLP           CHTF            T55              P55
                 .126723E+03     .203108E+01     .489764E-01     .109147E+03     .184906E+04     .109695E+01
                  T24              P24             WAG              WFD             WS24             FAR24
                 .760192E+03     .963880E+00     .117364E+03    0.                .117364E+03    0.
                  T25              P25             DPDUC            ETAD            AM25             AM55
                 .760192E+03     .560840E+00     .547941E-01    0.                .280798E+00     .540968E+00
                  ETAF             ETAI            ETAC             ETATHP          ETATIP           ETATLP
                 .827305E+00     .878268E+00     .835516E+00     .880339E+00     .876926E+00     .915349E+00
                  T6               P6              PS6              AM6             V6               WG6
                 .106105E+04     .992617E+00     .954412E+00     .239706E+00     .377156E+03     .157984E+03
                  T7               WFA             FAR7             ETAA            DPAFT            PS8
                 .106105E+04    0.                .570599E-02    0.               0.                .529014E+00
                  AM8              V8              PS9              AM9             V9               PS28
                 .100030E+01     .145508E+04     .445984E+00     .113624E+01     .161526E+04    0.
                  AM28             V28             PS29             AM29            V29              BYPASS
                0.               0.              0.               0.               0.                .295362E+01
                  HPEXT            WFT             WGT              VA              FRO              CVMNOZ
                0.                .296199E+08     .157996E+03     .174329E+04     .851214E+04     .960000E+00
                  VJM              CVDNOZ          VJD              FGM             FGP              A59
                 .158295E+04    0.               0.                .777276E+04     .328518E+04     .104001E+01
                  A25              A6              A8               A9              A28              A29
                 .647530E+01     .116201E+02     .461476E+01     .468251E+01    0.               0.

MAIN SHOCK OUTSIDE C-D NOZZLE   FG= 11057.94                 FN=  2945.80                         SFC= 1.26731
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                                SUPERSONIC FULL AFTERBURNING

NOZZLE DESIGN            A8=  .11057560E+02    AM8=  .10000000E+01    A9=  .19339090E+02    AM9=  .19724375E+01

OUTPUT                 AM=  1.600        ALTP= 50000.          T4= 2860.40         T7= 3700.00         ETAR=  .9445
                        PCNF            CNF              ZF               PRF              WAFC             WAF
                       .885761E+02     .795330E+00      .645492E+00      .163708E+01      .47755??+03      .157108E+03
                        PCNI            CNI              ZI               PRI              WAIC             WAI
                       .926054E+02     .872474E+00      .622463E+00      .295360E+01      .254618E+03      .397357E+02
                        PCNC            CNC              ZC               PRC              WACC             WAC
                       .180000E+03     .970185E+00      .772839E+00      .318868E+01      .954252E+02      .397237E+02
                        T2              P2               T21              P21              T22              P22
                       .643321E+03     .820975E+00      .760192E+03      .101658E+01      .106518E+04      .300258E+01
                        T3              P3               BLF              BLI              BLC              BLDU
                       .152572E+04     .955024E+01     0.               0.               0.               0.
                        BLOB            BLHP             BLIP             BLLP             T4               P4
                      0.               0.               0.               0.               .266040E+04      .909220E+01
                        WA3             WFB              WG4              FAR4             ETAB             DPCOM
                       .397237E+02     .896199E+00      .406199E+02      .225608E-01      .987500E+00      .479613E-01
                        TFFHP           CNHP             DHTCHP           DHTC             T45              P45
                       .500893E+02     .199986E+01      .405686E-01      .116074E+03      .247514E+04      .438759E+01
                        TFFIP           CNIP             DHTCIP           DHTI             T5               P5
                       .120519E+03     .203829E+01      .296827E-01      .734843E+02      .222672E+04      .259858E+01
                        TFFLP           CNLP             DHTCLP           DHTF             T55              P55
                       .126723E+03     .203108E+01      .489704E-01      .109147E+03      .184906E+04      .109695E+01
                        T24             P24              WAD              WFD              WG24             FAR24
                       .760192E+03     .960880E+00      .117364E+03     0.                .117364E+03     0.
                        T25             P25              DPCUC            ETAD             AM25             AM55
                       .760192E+03     .960880E+00      .547941E-01     0.                .280798E+00      .540960E+00
                        ETAF            ETAI             ETAC             ETATHP           ETATIP           ETATLP
                       .827305E+00     .878268E+00      .935916E+00      .880399E+00      .876926E+00      .915349E+00
                        T6              P6               PS6              AM6              V6               WG6
                       .106105E+04     .992617E+00      .954412E+00      .239734E+00      .377156E+03      .157984E+03
                        T7              WFA              FAR7             ETAA             DPAFT            PS8
                       .370000E+04     .857464E+01      .602581E-01      .850000E+00     0.                .467535E+00
                        AM8             V8               PS9              AM9              V9               PS28
                       .100000E+01     .266588E+04      .114456E+00      .197244E+01      .459923E+04     0.
                        AM28            V28              PS29             AM29             V29              BYPASS
                      0.               0.               0.               0.               0.                .295362E+01
                        HPEXT           WFT              WGT              VA               FRD              CVMNOZ
                      0.                .947884E+01      .166571E+03      .174329E+04      .851214E+04      .980000E+00
                        VJM             CVDNOZ           VJD              FGM              FGP              A55
                       .446885E+04     0.               0.                .231302E+05     0.                .184801E+01
                        A25             A6               A8               A9               A28              A29
                       .647581E+01     .116281E+02      .110576E+02      .193391E+02     0.               0.

MAIN SHOCK OUTSIDE C-D NOZZLE         FG= 23139.16                    FN= 14618.84                    SFC= 2.33239
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